1984 CB ANNUAL REPORT

SUMMARY OF DEVELOPMENT ACTIVITIES, COSTS AND ENVIRONMENTAL MONITORING

CB

CATHEDRAL BLUFFS SHALE OIL COMPANY
751 HORIZON COURT
GRAND JUNCTION, COLORADO 81501

APRIL 30, 1985

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April 30, 1985

Submitted by:

CATHEDRAL BLUFFS SHALE OIL COMPANY
751 Horizon Court
Grand Junction, Colorado 81501

to:

Mr. Lee Carie, Manager
Oil Shale Project Office
USDI - Bureau of Land Management
131 N. 6th Street - Suite 300
Grand Junction, Colorado 81501

FOREWORD

The 1984 CB ANNUAL REPORT is submitted to fulfill the requirements of Oil Shale Lease Number C-20341 as stated in Section 16(b) of the Lease, Section 1.(C)(4) of the Lease Environmental Stipulations, and Condition of Approval No. 3 of the Detailed Development Plan issued on August 30, 1977.

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1984 CB ANNUAL REPORT

SUMMARY OF DEVELOPMENT ACTIVITIES, COSTS AND ENVIRONMENTAL MONITORING

1.0 INTRODUCTION AND SUMMARY

This report summarizes the development activities, costs, and environmental monitoring on the Federal Oil Shale Lease Tract C-b during calendar year 1984. The Tract is leased to Cathedral Bluffs Shale Oil Company under U.S. Department of the Interior Lease Number C-20341. It is managed by the equal-interest partnership between Occidental Oil Shale, Inc. and Tenneco Shale Oil Company, doing business as Cathedral Bluffs Shale Oil Company. The Tract is located in Rio Blanco County in the Piceance Creek basin of northwestern Colorado.

CB Shale Oil Company (CBSOC) history and status through 1984 are summarized on Table 1-1, including recent Project proposed configurations and negotiations with the Synthetic Fuels Corporation (SFC). CBSOC has been moving toward development of a viable oil shale mining and retorting project. The activities which have occurred during the interim have been needed prior to the Project's development.

Regarding future outlook of the CB Project:

1) The Synthetic Fuels Corporation has a board quorum and approved policy guidelines.

2) The tentative CB plan is to develop a project under the SFC guidelines with alternative aboveground retort technology (other than Union B), and utilize Modified In-Situ technology.

3) CB is continuing discussions with the SFC Board. CB hopes to sign an agreement in fiscal year 1984/1985 with the SFC for project financial assistance.

TABLE 1-1

C-b Tract Chronology

1974

C-b Lease C-20341 signed.
Two year Environmental Baseline Program started.
Extensive coring program started.

1975

Environmental baseline monitoring and coring continued; cores converted to water monitoring wells.

1976

Detailed Development Plan submitted and approved in February by OSPO (surface retorting).
Two year Environmental Baseline Program completed.
Lease suspension period commenced.

1977

Lease suspension period ended.
Modified Detailed Development Plan submitted and approved in February by OSPO (Modified In-Situ retorting).
Site preparation activity initiated.
PSD permit issued by EPA for MIS Ancillary Facilities (12/15/77).

1978

Commenced construction of Project facilities (in accord with EPA PSD permit) by setting collars for each shaft - 15 ft. V/E shaft, 29 ft. production shaft, 34 ft. service shaft.
Construction of headframes for all three shafts was completed.
Cement batch plant became operational.
Work began on water management system - two five-acre holding ponds - A and B.
Development Monitoring Plan completed and implemented.

1979

Sinking of the production, service and V/E shafts commenced.
Completed holding ponds A & B and commenced treatment of water for discharge under NPDES permit.
Hydrologic monitoring expanded for Water Augmentation Plan in accord with Court Decree.

1980

Sinking of the three shafts continued.
Continued utilization of the water management system; completed construction of sprinkler irrigation system, additional water treatment facilities; and commenced testing sprinkler irrigation methods.
Five offices, two labs constructed.
Submitted proposal for financial assistance to DOE (Nov.) under the Federal Non-Nuclear Research and Development Act.

1981

Sinking of the three shafts completed.
Outfitting of the production and service shaft headframes commenced.
Water management system expanded to include holding pond C and reinjection system. Complete system operational. Reinjection testing completed. Discharge under NPDES permit continuing.
Three contractor's offices added along with mine power substation, natural gas supply building, sewage treatment plant, slabs for both changehouse and warehouse buildings, manway tunnels, and utility tunnels.
Dewatering of V/E shaft was discontinued following OSPO approval.
CBSOC announced that Project was to be reassessed; major plant construction was put on hold.

TABLE 1-1 (Cont'd)

1982

Construction activities were reduced while Project planning and economics were reassessed.

Intense Project activity to prepare three proposals to Synthetic Fuels Corp. (SFC) for revised scope (submitted in 1983).

Continued outfitting of headframes of service and production shafts for hoisting.

Continued use of water management system to treat mine water for reinjection or discharge under NPDES permit.

Completed the control room (for hoists), airlocks, and mechanical/electrical shops.

Completed construction of on-Tract power substation and it became operational.

Submitted application to EPA for PSD amendment to modify permitted facilities by constructing 12,000 bpd aboveground retort and 15,000 bpd oil upgrading plant.

CB participated in procedures to finalize construction of by-pass highway around City of Rifle.

Although no new acreages were disturbed, two drill pads of 0.5 acre each were revegetated.

1983

Proposal for financial assistance submitted to SFC in January; scope of this Project was to produce 14,100 bbls per calendar day of shale oil, and included:

1) One commercial scale aboveground retort (AGR) using the Unishale B process;
2) Four continuously burning MIS retorts;
3) Room-and-pillar and MIS mining;
4) Oil upgrading facility.

Letter of Intent received from SFC in July to provide up to $2.19 billion in support for Project.

Project Level II/Level III Design and Cost Estimates completed.

Commissioning of the production, service and auxiliary hoists completed.

Continued mine dewatering and use of water management system to treat mine water for discharge under NPDES permit.

Continued geotechnical program to obtain ore sample for Union retort tests and to assess fines generation and to obtain additional core samples for further resource evaluations.

PSD permit issued by EPA in September for modification to permitted facility by constructing 12,000 bpd retorting and 15,000 bpd oil upgrading facility.

Completed installation of the automated mine gas monitoring system.

Work was initiated on a Revised Detailed Development Plan (RDDP) and on a Mined Land Reclamation Permit to reflect the 14,100 bbl/day Project.

Contractor initiated work to perform tests to characterize CB Unishale spent shale so as to define proposed design of spent shale embankment.

New acreages which were disturbed from six drill pads consisted of 3 acres; no new acreages were revegetated.

A spent shale revegetation demonstration plot utilizing C-b shale retorted by the Union B process was constructed.

TABLE 1-1(Cont'd)

1984

Continued Project negotiations with the SFC:

1) SFC Board notified U.S. Treasury to set aside Loan and Price Guarantees for CBSOC (April);
2) SFC Board members step down, and as a result a quorum no longer exists;
3) Work continued with SFC staff in preparing a draft Information Memorandum;
4) Work continued on negotiating a Committment to Guarantee;
5) New SFC Board members were appointed (December); a quorum was re-established;
6) No contract was secured with SFC in 1984.

Submitted first draft of Revised Detailed Development Plan (RDDP) in February to OSPO.

Presented RDDP to Oil Shale Environmental Advisory Panel (March).

Completed CB/USBM cooperative drilling program to study methane emanation rates in oil shale.

Initiated construction to provide space for a hoist control room.

Continuing program of mining bulk ore samples for testing.

Continued preparation of final draft of RDDP; issuance delayed pending Project definition.

AGR Design Test Run for CB received from Union Oil Company (May).

Completed major upgrading and rebuilding of the underground mine electrical system and pump stations.

Initiated work on raw and spent shale leaching studies.

A natural gas pipeline was installed on Tract from the main-line termination point near the generator building to the shaft heater and maintenance shop area; natural gas then replaced propane for the shaft heater.

Raw and spent shale characterization report completed (September).

A second spent shale revegetation plot was constructed (summer) and seeded (October).

No new acreages were disturbed; 6 corehole drillpads were reclaimd.

Spent shale disposal test work report drafted; modifications in process.

Continuing mine dewatering and use of water management system to treat water for discharge under NPDES permit.

Continuing engineering and project cost studies.

Continuing CB site operation and maintenance.

Project expenditures in 1984 were $10,571,000.

Principal activities on-Tract in 1984 were the initiation of construction to provide space for a hoist control room, the continuation of mining of the bulk ore samples for testing purposes, the installation of a natural gas pipeline extension from the generator building to the mine air heating and maintenance shop, continuation of the water management program to treat and dispose of excess waters associated with mine dewatering, and routine facility maintenance. One new structure was added in 1984 - a mine rescue trailer.

A bulk sample of oil shale was mined in 1984 on the upper and lower level stations (see Figures 4-8 and 4-9). Approximately 450 tons of rock on the upper level and 350 tons of rock on the lower level were mined. The upper level rock containing 45 gpt mixed with the lower level rock containing 20 gpt yields a product of 37 gpt. This material is consistent with grades used to test the Union pilot retort with CB run-of-mine grade rock. The rock was crushed and screened with the feeder breaker and crusher to reduce it to feed size for the Union pilot retort.

Additional mining was done on the lower level in the underground elecrical equipment room drift (see Figure 4-9). Approximately 300 tons of rock were removed from the walls and floor to allow sufficient space for electrical equipment and loading pocket controls (i.e., the hoist control room, referenced above) which will be installed at a later time.

Water make for the shafts was as follows:

Shaft	Total for 1984 (million gal)	Cumulative Total To Date (million gal)
Ventilation/Escape	0	679
Production and Service	201.5	1246
TOTAL	201.5 (231.5)	1925* (1723)

Quantities for 1983 are shown in parentheses.

* An additional 18 million gal have been pumped from small wells for on-Tract use bringing the grand total to 1943 million gal.

The approved inactivation of the ventilation/escape (V/E) shaft dewatering system in September 1981 continued through 1984.

The 1984 water management was achieved via direct discharge from on-Tract holding ponds under the NPDES permit. Following the inactivation of the V/E shaft and subsequent declines in dewatering rates the reinjection mode was temporarily discontinued in July 1982. To summarize for the year 1984:

177	million	gal were discharged,
0	"	gal were reinjected,
0	"	gal were sprinkler irrigated,
17.7	"	gal were used or stored,
6.8	"	gal were lost to evaporation and seepage, and
201.5	million	gal were pumped.

There were no areas of new disturbance in 1984. Total disturbed acreage remains at 191. Six drill pads of the 1983 core sampling program were reclaimed in 1984 corresponding to 3 acres, bringing the total reclaimed acreage to 38.

Regarding environmental and health protection and control, in addition to water management already discussed, the following should be noted:

- Regarding air emissions, the cement batch plant ceased operation in 1982 and remained out of operation in 1983 and 1984.

- No substantial degradation in visual range has been noted since inception of the visibility program in 1975; none is judged to be due to CB.

- A 9,000 gal/day capacity sewage treatment plan ceased operation in March of 1982 and remained out of operation in 1984. At present, the sewage is being disposed via porta-johns; and an approved sewage system that has been in operation for nine years is utilized to dispose of that from the C-b offices.

- 4 reportable accidents in 44,659 man hours on-Tract during 1984 resulted in an accident incident rate of 17.15. A program to reduce this incident rate is underway through training, job safety analysis and conduct of frequent safety meetings.

- Special reflectors, installed along four one-mile sections of Piceance Creek Road in 1981 as a mitigation test to reduce deer road kill, continued to be used from 1982 thru 1984. Fewer deer are killed where reflectors are used.

Regarding socioeconomic impacts, the 1984 CB work force on Tract decreased from a year-end level of 20 in 1983 to a year-end level of 17 in 1984. Total persons employed directly by CB, including Grand Junction staff, decreased 27% from 84 in December 1983 to 61 in December 1984. In mid November of 1983, CB submitted a Major Development Permit Application to Rio Blanco County. Discussions over socioeconomic mitigation plans continued during 1984 with Rio Blanco and Garfield counties. Final agreement on these plans has not been reached.

Environmental monitoring has continued as an ongoing activity at the Tract since the completion of the two-year Baseline period (1974-1976). It encompasses air, water, biology and health and safety. Results are summarized in Section 9 of this volume. No significant environmental impacts have been noted to date except for areas directly disturbed by drilling, construction, ponds, and mined rock disposal, drawdown of groundwater levels from mine dewatering, some vegetation effects in previously sprinkler-irrigated areas, and increasing fluoride values in one spring (north of the Tract).

The following project abbreviations appear in this report:

CB - for Cathedral Bluffs, and
C-b - for Colorado-b Federal Oil Shale Lease Tract.

2.0 DESCRIPTION OF PROJECT AREA

2.1 Location

No change in status from last year.

2.2 Legal Description of the Leased Land

No change.

2.3 Leasehold Status

No change.

3.0 PROJECT STATUS, SCHEDULE AND COSTS

3.1 Project Status

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Status of the Project with regard to environmental protection and control and permitting is summarized in Section 7.0.

3.2 Schedule

The OSPO approved "Milestone" or Project Guide Schedule (as approved in 1978) has appeared in all past Annual Reports. Inasmuch as it has not changed, it is not repeated here. This schedule has been modified by subsequent OSPO action as follows:

- An interim operation plan was approved on September 1, 1981 which allows the V/E Shaft to fill with water until it is necessary to draw down the water for mine development.

- An Interim Monitoring Program was approved on March 17, 1982 (Rutledge, 1982a) and revised on July 22, 1982 (Rutledge, 1982b) to reflect the reduced level of activity on Tract through March 1983. The Interim Monitoring Program has recently been extended into 1985 until such time as a Revised Detailed Development Plan is approved.

- An Interim Development Program and Schedule was approved on July 22, 1982 (Rutledge, 1982c) to reflect the reduced level of activity commensurate with the December, 1981 announcement by CB management that the entire project was being reassesed due to oil prices, interest rates and project costs. Further extensions were granted in 1983 and 1985 (Hoffman, 1983a and 1983b) and (Carie, 1985).

The proposed Project schedule milestones are given on Figure 3-1, subject to Project uncertainties.

As in 1983, on-Tract activities in 1984 were significantly reduced; on-site construction in 1984 has been delineated in Table 1-1. The major contractors on Tract are noted in Table 3-1.

3.3 Costs

Financial information for 1984 is presented in Table 3-2 for the following categories: mine capital, surface capital and unallocated support. Total expenditures for the year were $10,571,000.

FIGURE 3-1 Project Schedule Milestones*

* Due to external or other factors the dates set forth below are approximate and thus are subject to change. CB will provide OSPO with refinements of these dates as soon as they are available.

Item	Date
Aboveground Retort	
Confirmation & Engineering Start	Mid 1985
Construction Start	Mid 1986
Retort Start-Up	1989
Modified-In-Situ	
Preproduction Engineering Start	Mid 1985
Construction (Resumption of Project Construction)	Late 1985
Mining Start	Mid 1986
Surface Processing Facilities	
Engineering Start	Mid 1985
Construction Start	Mid 1986
MIS Retort Start-Up	1988
Permit Amendments	
PSD/APEN's	Late 1985
RDDP Submittal	Late 1985 to early 1986
MLR Submittal	Late 1985 to early 1986

TABLE 3-1

1984 Major Contractors and Responsibilities

Bechtel	Project definition studies
Colo-Macco	Operation and maintenance labor
Fluor	Project definition studies
Geothermal Surveys, Inc.	Hydrologic monitoring & data analysis
Mariah Associates	Aquatic sampling
Stearns-Catalytic	Project definition studies
Stoecker-Keammerer & Associates	Vegetation and wildlife monitoring
Union Oil	Process pilot plant studies
U.S. Bureau of Mines	Dust explosivity studies
In-Situ, Inc.	Spent shale disposal studies
Crane & Associates	Socioeconomic monitoring

TABLE 3-2

1984 CB Expenditures
(Thousands of $'s)

MINE CAPITAL			
Mine Construction or Development		$ 95	
Plant Services		1407	
Health, Safety and Security		336	
			$ 1838
SURFACE CAPITAL			
Engineering Capital			1149
UNALLOCATED SUPPORT			
Engineering		3070	
Administration		2940	
Environmental			
Staff	$ 705		
Air Monitoring	41		
Water Monitoring	152		
Biology/Reclamation	53		
Permits	55		
Water Supply	66		
Reports	12		
Computer Service	53		
		1137	
Socioeconomic		141	
Ad Valorem Tax		296	
			7584
TOTAL			$10571

4.0 DEVELOPMENT ACTIVITIES

4.1 On-Tract Facilities Description

4.1.1 General Arrangement

Activities in 1984 consisted primarily of maintenance of all site facilities and minor construction modifications to existing installations. One new building, the Mine Rescue Trailer, has been located in the Mine Support Area and equipped for use in an emergency.

Existing on-tract facilities are shown in the following figures:

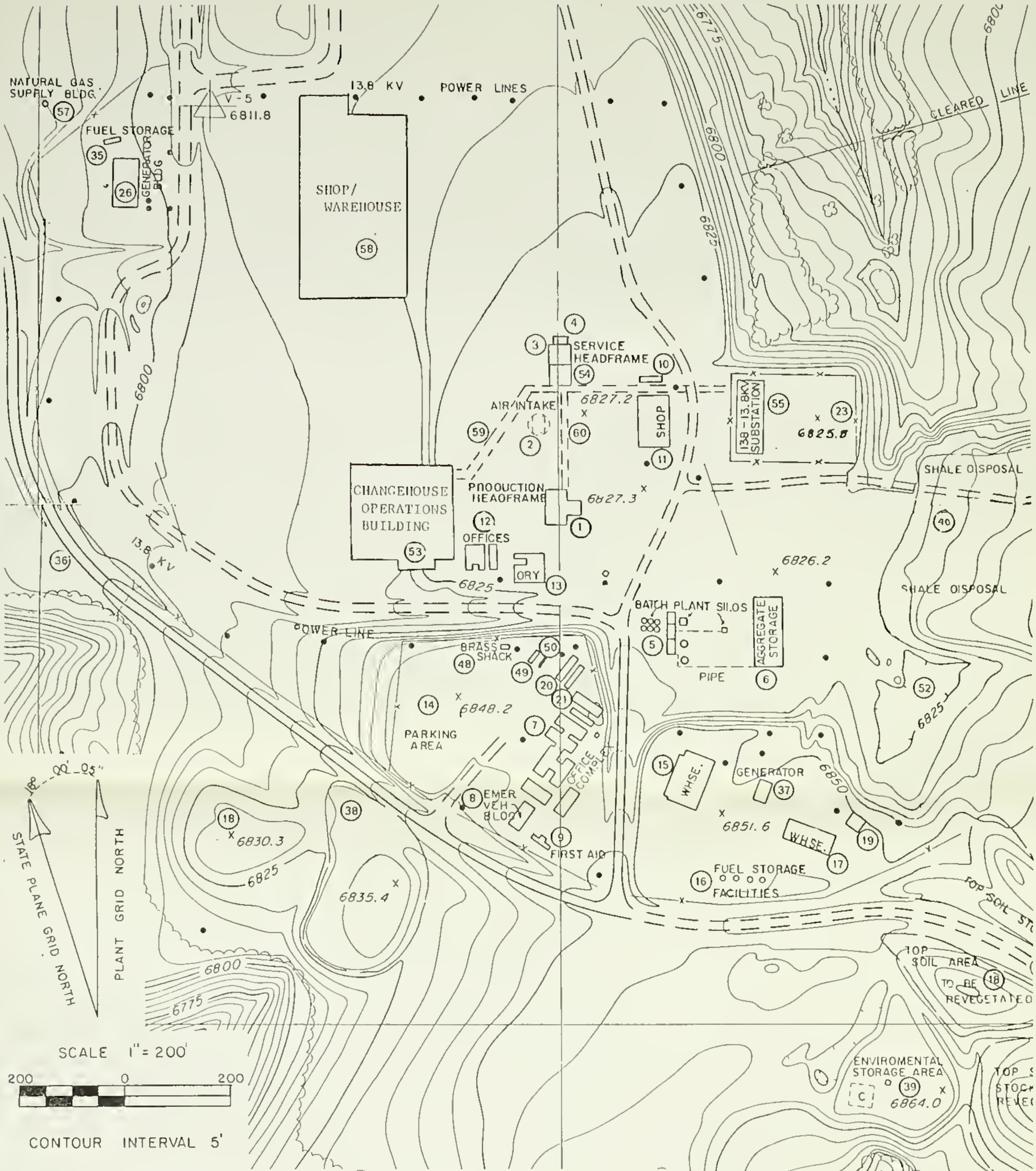
- Figure 4-1: C-b Tract Topographic Map (Jacket Map)
- Figure 4-2: Mine Support Area
- Figure 4-3: V/E Shaft and Ponds A & B
- Figure 4-4: Guard Building and Heliport
- Figure 4-5: Pond C Area
- Figure 4-6: Explosives Storage Area

Table 4-1 is the key to the numbers shown on Figures 4-1 through 4-6.

Facilities that were removed in previous years have been taken off the figures and the numbering sequence starred to indicate this. These figures should be compared with those of previous years for description of removed facilities. Site facilities are being maintained until construction activities are resumed.

4.1.2 Production Shaft Headframe

The Production Shaft and Headframe will serve as the main "mined-rock" hoisting facility during commercial operation. Construction of the 29-foot diameter Production Shaft was begun early in 1978. By the end of 1978, the concrete shell of the headframe was completed and shaft sinking activities were started. Construction inside the headframe and setting of equipment in the headframe started again in 1981. The largest pieces of equipment installed



1. Production Headframe
2. Air Intake Shaft
3. Service Headframe
4. Control Room
5. Cement Batch Plant
6. Cement Batch Plant Aggregate Storage
7. Office Complex
8. Emergency Vehicle Bldg.
9. First Aid Trailer
10. Mine Rescue Trailer
11. Shop
12. Offices
13. Dry
14. Parking Area
15. Main Warehouse
16. Fuel Storage Facilities
17. Warehouse
18. Topsoil Storage Area
19. Storage Building
20. Office Trailer
21. Office Trailer
22. *
23. Colorado Ute Switchyard
24. *
25. *
26. Generator Building
27. *
35. Fuel Storage
36. Paved Main Access Road
37. Generator
38. Storage Yard
39. Environmental Storage Bldg.
40. Shale Disposal Area
48. Brass Shack
49. Hydrology/Air Laboratory
50. Soils Lab
51. *
52. Fenced Storage Area
53. Changehouse/Operations Building (slabs only)
54. Mechanical Room-Service Shaft
55. Mine Support Area Substation
57. Natural Gas Supply Bldg.
58. Warehouse/Maintenance Shop (slabs only)
59. Manway Tunnel from Changehouse to Service Headframe.
60. Utility Tunnels from Substation to Service/ Production Headframes and Changehouse
61 *

* = Building removed in previous years

Figure 4-2

Topographic map showing facilities in the Mine Support Area

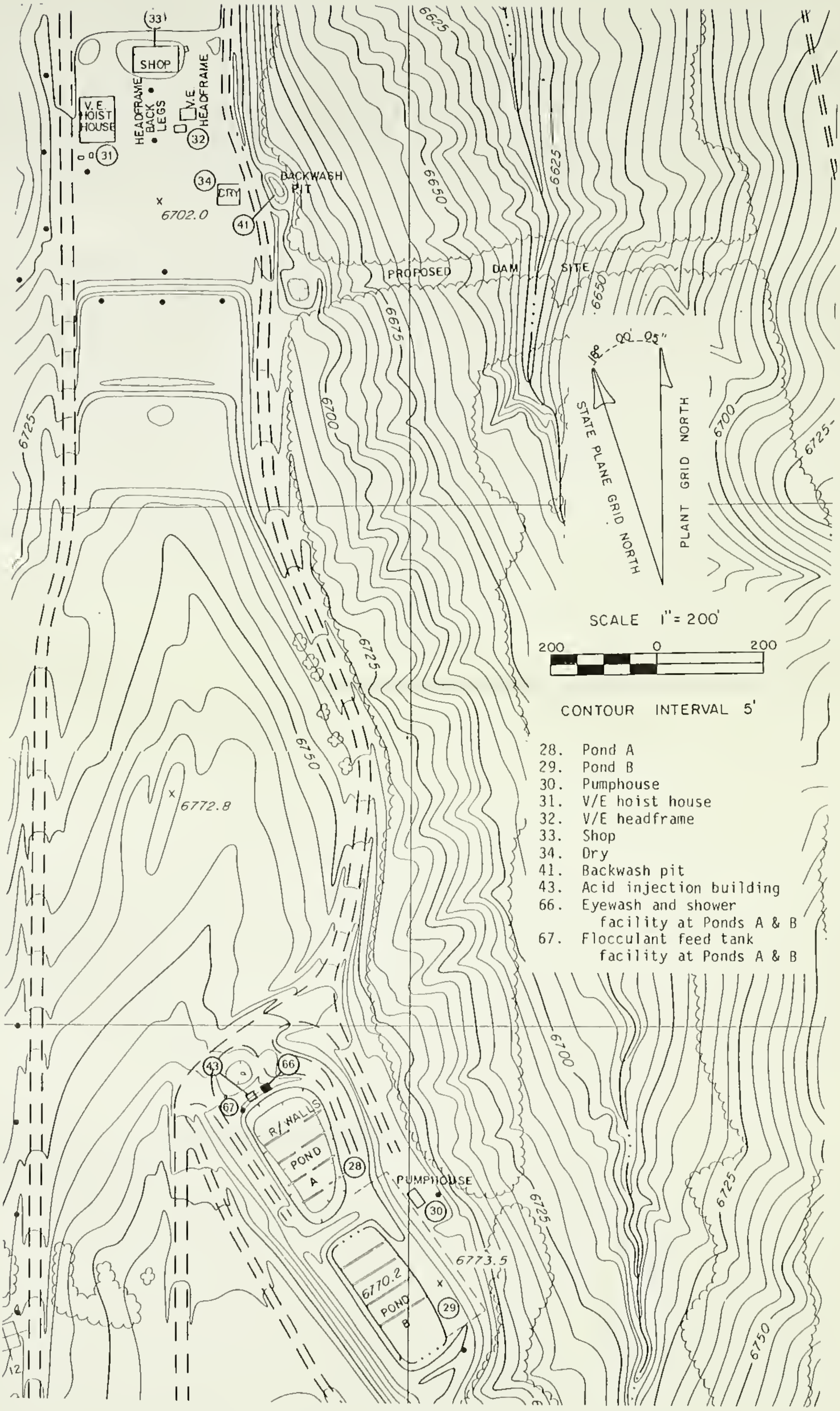


Figure 4-3

Topographic map showing facilities near the V/E Shaft and Ponds A and B

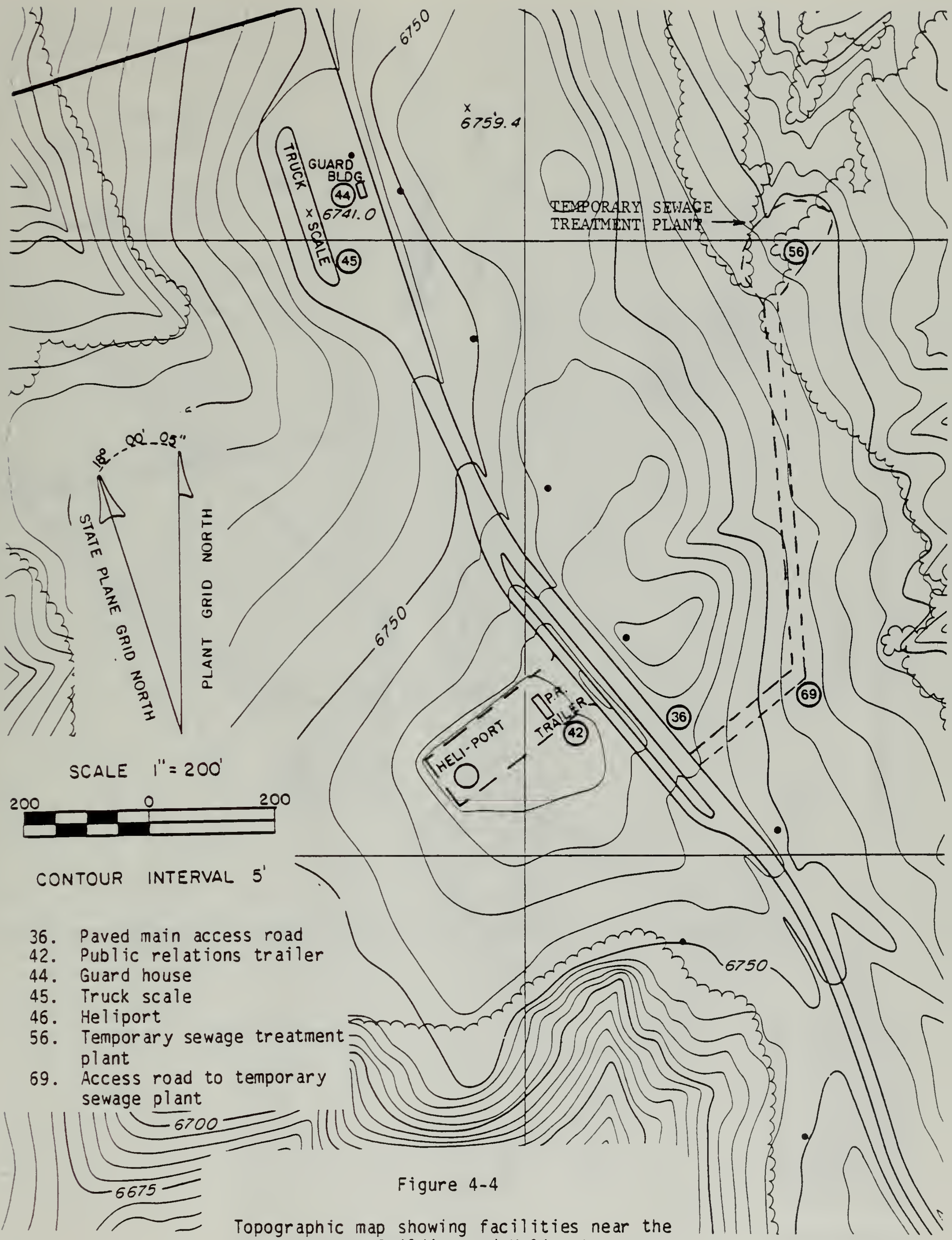
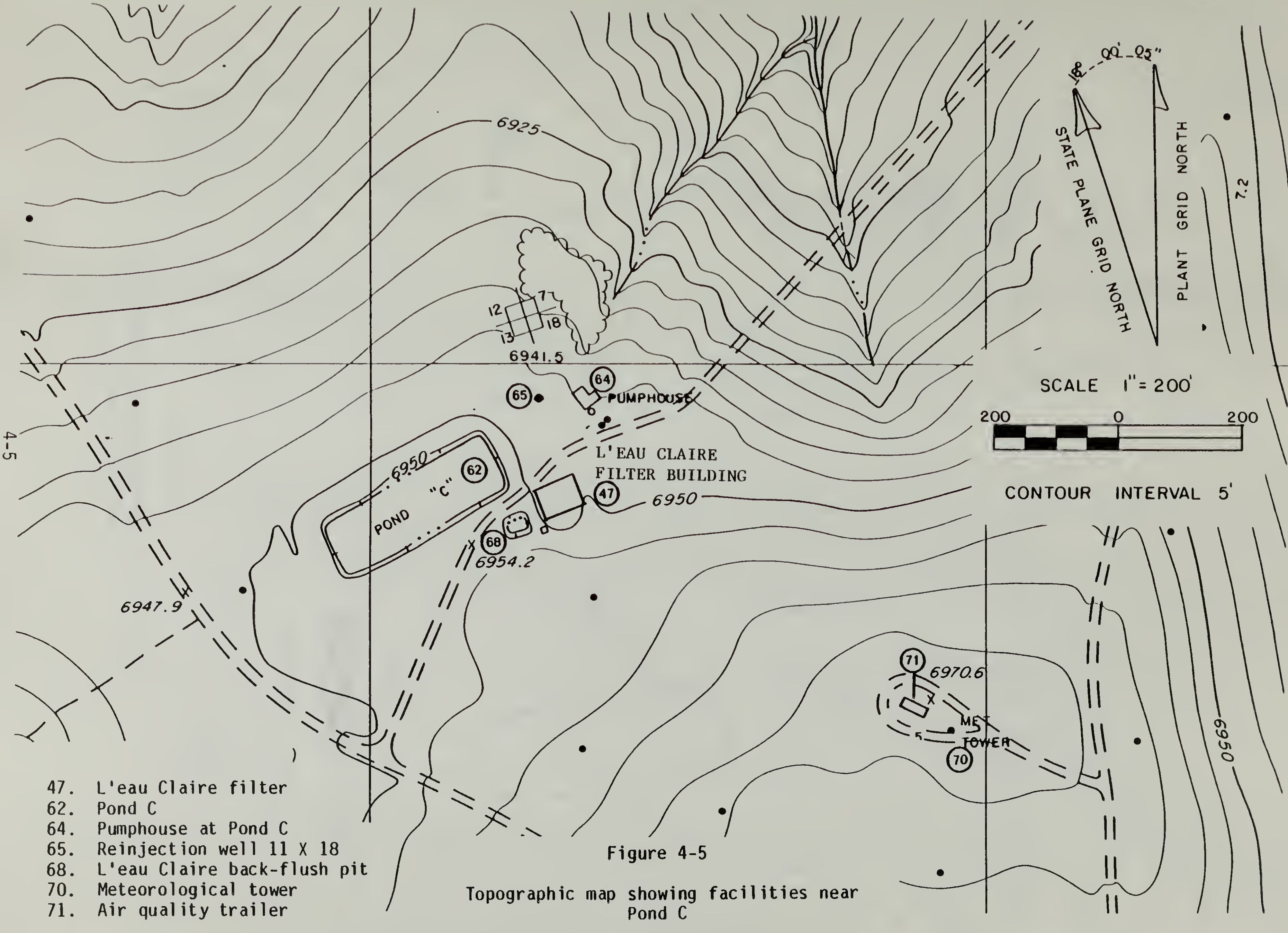


Figure 4-4

Topographic map showing facilities near the Guard Building and Heliport



47. L'eau Claire filter
62. Pond C
64. Pumphouse at Pond C
65. Reinjection well 11 X 18
68. L'eau Claire back-flush pit
70. Meteorological tower
71. Air quality trailer

Figure 4-5

Topographic map showing facilities near Pond C

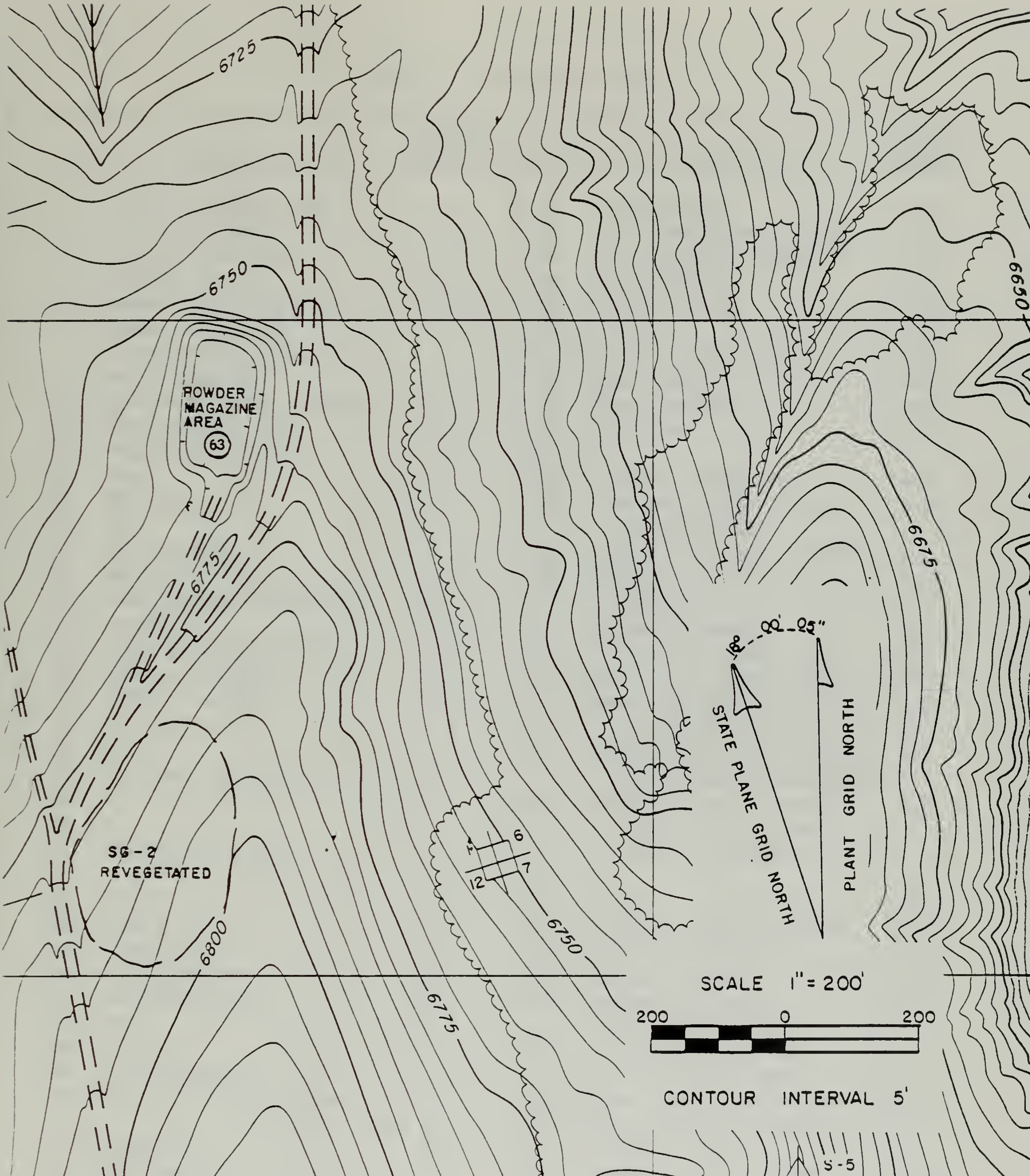


Figure 4-6

Topographic map showing facilities near the Explosives Storage Area

TABLE 4-1 Facilities List

Facility	Figure Number	Facility	Figure Number
1. Production Headframe	4-2	41. Backwash Pit	4-3
2. Air Intake Shaft	4-2	42. Public Relations Trailer	4-4
3. Service Headframe	4-2	43. Acid Injection Bldg.	4-3
4. Control Room	4-2	44. Guard House	4-4
5. Cement Batch Plant	4-2	45. Truck Scale	4-4
6. Cement Batch Plant Aggregate Storage	4-2	46. Heliport	4-4
		47. L'eau Claire Filter	4-5
7. Office Complex	4-2	48. Brass Shack	4-2
8. Emergency Vehicle Bldg.	4-2	49. Hydro/Air Lab	4-2
9. First Aid Trailer	4-2	50. Soils Lab	4-2
10. Mine Rescue Trailer	4-2	51. *	
11. Shop	4-2	52. Fenced Storage Area	4-2
12. Offices	4-2	53. Changehouse/Operations Building Slab	4-2
13. Dry	4-2		
14. Parking Area	4-2	54. Mechanical Room - S/Shaft	4-2
15. Main Warehouse	4-2	55. Mine Support Area Substation	4-2
16. Fuel Storage Facilities	4-2		
17. Warehouse	4-2	56. Temporary Sewage Treatment Plant	4-4
18. Topsoil Storage Area	4-2		
19. Storage Building	4-2	57. Natural Gas Supply Bldg.	4-2
20. Office Trailer	4-2	58. Warehouse/Maintenance Shop Building Slab	4-2
21. Office Trailer	4-2		
22. *		59. Manway Tunnel from Change-house to Serv. Headframe	4-2
23. Colorado Ute Switchyard	4-2		
24. *		60. Utility Tunnels from Sub-station to S/P Head-frames & Changehouse	4-2
25. *			
26. Generator Building	4-2		
27. *		61. *	
28. Pond A	4-3	62. Pond C	4-5
29. Pond B	4-3	63. Explosives Storage Area	4-6
30. Pumphouse	4-3	64. Pumphouse at Pond C	4-5
31. V/E Hoist House	4-3	65. Reinjection Well	4-5
32. V/E Headframe	4-3	66. Eyewash and Shower Facility at Ponds A & B	4-3
33. Shop	4-3		
34. Dry	4-3	67. Flocculant Feed Tank Facility at Ponds A & B	4-3
35. Fuel Storage	4-2		
36. Paved Main Access Road	4-2 and 4-4	68. L'eau Claire Back-Flush Pit	4-5
		69. Access Road to Temporary Sewage Plant	4-4
37. Generator	4-2		
38. Storage Yard	4-2	70. Meteorological Tower	4-5
39. Environmental Storage Bldg.	4-2	71. Air Quality Trailer (Station 023)	4-5
40. Shale Disposal Area	4-2		

* Facilities since removed; see Figure 4-2

in the headframe were two 9500-hp production hoists built by Canadian General Electric. Commissioning of the production hoists and all other equipment was completed in 1983.

Work in the Production Headframe for 1984 was limited to maintenance, minor repairs, and cleanup of the equipment. Maintenance work that is performed on a regular basis includes: lubrication of the hoist ropes, regrooving the hoist drum, nondestructive testing of the hoist ropes, and hoist operation maintenance. Other work in the headframe included a safety drop test on the elevator, installation of dump rollers on the skips, repairing aircraft warning lights, and installation of additional handrails on ventilation fan platforms.

4.1.3 Service Shaft Headframe

The 34-foot diameter Service Shaft will be used for hoisting both men and materials and as a ventilation air intake. Construction commenced in 1978 and the headframe shell was completed that year. Following shaft sinking, construction began again in the headframe in 1981. At this time, the headframe installation was completed and three service and materials hoists were installed. One hoist, a 1500-hp friction hoist built by Canadian General Electric and two smaller 300-hp auxiliary hoists built by Bertram Nordberg were installed. The hoist installation and headframe equipping was completed in 1982 with final commissioning of the hoists in 1983.

Maintenance work was the major activity in the Service Headframe in 1984. Nondestructive testing and lubrication of the hoist ropes were carried out on a quarterly basis. The auxiliary cage hoists required more maintenance than the other hoists because of their greater use. Maintenance items on the auxiliary cages and hoists included cleaning the brakes, changing rigid guide rollers to pneumatic type, replacing the trailing cables, and the annual shortening of the hoist ropes. Rope inspection platforms were installed. Phone and signal systems were installed for the main cage, counterweight, and at inspection platforms.

4.1.4 Ventilation/Escape Hoist and Headframe

Construction of the 15-foot diameter Ventilation/Escape Shaft hoist house, headframe, and surface facilities were started in 1978 and completed in 1979. The hoist house encloses a double-drum hoist built by Nordberg, having dual 1000-hp motors, and all the equipment associated with the hoist. Two surface buildings were constructed to house the shop and dry facilities. This area was used until the end of 1981 when dewatering of the shaft ceased, and it was allowed to flood. Since then only maintenance and cleanup work has been performed.

4.1.5 Electric Power and Switching Facilities

Electrical power for the Site is supplied by Colorado Ute Electric at 138 kV. At the Mine Support Area Substation, the power is transformed down to 13.8 kV and 5 kV for distribution to the facilities around the site. The substation was energized in April of 1982; and at that time the 1000-kW natural-gas-powered generators which had supplied site power were shut down. Four of these generators are maintained for emergency power.

4.1.6 Water Wells

Water for site use is hauled via truck from well 24X25 on Piceance Creek during the warmer months. During the winter months, water is supplied from the mine water ponds, and clearly-labeled non-potable. Bottled water is used for drinking purposes.

4.1.7 Office, Warehouse, and Shop Facilities

One new building, the mine rescue trailer, was added to the facilities in 1984. The trailer has been located adjacent to the shop and is shown on Figure 4-2 as building number 10. All existing facilities are shown on Figures 4-1 (jacket map), 4-2 through 4-6, and the facilities list (Table 4-1).

4.1.8 Concrete Batch Plant

A concrete Batch Plant was set up in 1978 during the initial construction

of the headframes. This plant supplied concrete for all of the construction on the site. The facility is equipped with cement storage silos, aggregate storage building, boiler building, concrete measuring and mixing facility, and control room. The plant was shut down in 1982 but is being maintained until construction activities are resumed.

4.1.9 Explosives Storage and Use

The explosives storage (powder magazine) area is, as shown on Figure 4-6, remotely located from areas of major activity. Explosives use for 1984 consisted of 825 nonelectric blasting caps and 2000 pounds of stick explosives. These explosives were used for the mining of the bulk mining sample and electrical equipment room mining described in section 4.4.2.

4.1.10 Water Treatment Facilities

There were no changes made to the surface water treatment facilities in 1984. Some testing was carried out on an electrodialysis demineralizer which is one of the possible demineralizing systems for use in the commercial operations.

The electrodialysis unit was run on upper aquifer water and also on mine water being discharged from Ponds A and B. The unit successfully reduced the total dissolved solids (TDS) content of the water to around 200 ppm. This would be suitable for use, after chlorination, as potable water and as feed to an ion exchange demineralizer producing boiler feed water. Testing is continuing to refine the solids filtering system necessary for commercial application.

A total of 201.5 million gallons was pumped from the shafts in 1984, compared to 231.5 million gallons in 1983. Its deposition and use by month is given in Table 4-2. In 1984 the only method of treatment of mine water was temporary storage in Ponds A and B to settle solids followed by discharge, via East No Name Gulch to Piceance Creek under valid NPDES permit (Colorado Department of Health, 1983, 1984). Flow metering of the NPDES discharge has been accurate to approximately 5-10%. For the years 1981 to 1984 the overall water treatment-and-use summary is:

6

TABLE 4-2 1984 C-b Water Usage (10**6 Gallons, * = Acre Feet)

1984 C-B WATER USAGE (10**6 GALLONS, * =ACRE FEET)

	USE	SOURCE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL YTD	TOTAL YRS TD
ALL SHAFTS	GLAND WTR	PUMP STA														190.6
																584.9*
*TOTAL ALL SHAFTS																190.6
																584.9*
OFF-TRACT WTR US	POTABLE	TWN RIFLE														1.3
																4.0*
*TOTAL OFF-TRACT WTR US																1.3
																4.0*
TRACT WATER USED	BATCH PLNT	24X-25														2.4
																7.5*
	CONSTR	PONDS	.01	.01	.01	.01						.01	.01	.01	.07	18.1
			.03*	.03*	.03*	.03*						.03*	.03*	.03*	.21*	55.5*
	CONSTR	24X-25					.01	.02	.01	.01	.01				.06	1.8
							.03*	.06*	.03*	.03*	.03*				.18*	5.6*
	DUST CNTL	PONDS					.01	.01							.02	6.7
							.03*	.03*							.06*	20.6*
	EVP & LEAK	POND C														144.8
																444.4*
	NPDES REL	PONDS	16.98	15.50	16.38	15.53	15.78	15.14	14.33	13.80	13.79	13.18	13.11	13.51	177.03	1,185.1
			52.10*	47.56*	50.26*	47.65*	48.42*	46.46*	43.97*	42.34*	42.31*	40.44*	40.23*	41.45*	543.20*	3,636.5*
	REINJECT	PONDS														225.7
																692.6*
	SPR IRRIG	POND C														79.0
																242.5*
*TOTAL TRACT WATER USED			16.99	15.51	16.39	15.54	15.80	15.17	14.36	13.81	13.80	13.19	13.12	13.52	177.18	1,663.8
			52.13*	47.59*	50.29*	47.68*	48.48*	46.55*	44.00*	42.37*	42.34*	40.47*	40.26*	41.49*	543.66*	5,105.3*
WATER IN STORAGE	-	POND A	1.00	1.00	1.00	1.00	1.00					1.50	1.50	1.50		
			3.07*	3.07*	3.07*	3.07*	3.07*					4.60*	4.60*	4.60*		
	-	POND B	.15	.15	.15	.15	.15	.15	.15	1.50	1.50	.70	.70	.70		
			.46*	.46*	.46*	.46*	.46*	.46*	.46*	4.60*	4.60*	2.15*	2.15*	2.15*		
	-	POND C														
*TOTAL WATER IN STORAGE			1.15	1.15	1.15	1.15	1.15	.15	.15	1.50	1.50	2.20	2.20	2.20		
			3.53*	3.53*	3.53*	3.53*	3.53*	.46*	.46*	4.60*	4.60*	6.75*	6.75*	6.75*		
WATER PUMPED	-	33X-1														4.3
																13.2*
	-	24X-25					.01	.02	.01	.01	.01				.06	8.1
							.03*	.06*	.03*	.03*	.03*				.18*	24.9*
	-	32X-12														5.9
																18.0*
	-	V/E SHAFT														678.9
																2,083.1*
	-	PROD & SERV	17.92	16.53	17.52	16.82	16.92	16.85	17.35	17.14	16.35	16.46	15.60	16.03	201.49	1,245.9
			54.99*	50.72*	53.76*	51.61*	51.92*	51.70*	53.24*	52.59*	50.17*	50.51*	47.87*	49.19*	618.26*	3,823.0*
*TOTAL WATER PUMPED			17.92	16.53	17.52	16.82	16.93	16.87	17.36	17.15	16.36	16.46	15.60	16.03	201.55	1,943.1
			54.99*	50.72*	53.76*	51.61*	51.95*	51.76*	53.27*	52.62*	50.20*	50.51*	47.87*	49.19*	618.44*	5,962.2*

	1981	1982	1983	1984
	(10^6 gallons)			
Total water pumped from shafts	634	291	231.5	201.5
Water used, evaporated, etc.	164	30	13.0	24.5
Water treated				
NPDES surface discharge	331	134	218.5	177
Reinjected	99	127	0	0
Sprinkler irrigated	40	0	0	0
Total treated	470	261	218.5	177

Further water management aspects are discussed in Section 7.2.

4.1.11 Hydrology Laboratory

This lab is equipped with all the necessary laboratory and safety equipment and supplies to ensure the proper preparation and testing of field water samples: pH, temperature, conductivity, dissolved oxygen, total suspended solids and fluoride. Samples for additional water quality parameter determination are labeled, preserved, and were transported to Cathedral Bluffs' Grand Junction Laboratory for analysis or shipment to a commercial laboratory. The Grand Junction Laboratory was closed in November 1984. All samples are now sent to commercial laboratories for analysis. This program includes blank, split, and spiked samples, as necessary, for the CB quality assurance program.

4.1.12 Permanent Mine Support Buildings

Construction of additional permanent Mine Support Buildings was suspended in 1982. Maintenance work on the existing facilities is the only work activity since that time.

4.1.13 Off-Tract Engineering Studies

Union Oil Company of California

Approximately 120 tons of C-b Tract shale were processed in Union Oil Company's Unishale B pilot retort in Brea, California.

Stearns-Catalytic Corporation

Stearns-Catalytic Corporation, Denver, continued to provide engineering services in the area of Surface Materials Handling and Aboveground Retorting Facilities.

In-Situ, Inc.

In-Situ, Inc., a Denver based geotechnical consultant, carried out physical characterization of the spent shale, derived from the AGR test runs carried out on the C-b Tract shale in Union's pilot plant, to establish an overall spent shale disposal plan for the CB Project. A plan jointly developed by In-Situ and Stearns-Catalytic will be submitted to the Colorado Mined Land Reclamation Board for approval.

In addition, raw shale moisture tests on the run-of-mine and AGR feed material were conducted to confirm design basis.

Analytical Laboratories

Several outside laboratories (J&A Associates of Golden, Colorado; Truesdail Laboratories of Tustin, California; Colorado State University and Wyoming Analytical Laboratories) were retained to carry out necessary tests on the C-b Tract oil shale samples to establish mineralogy of this resource and to determine overall heat of retorting. John W. Smith, a consultant, was also retained to interpret the analytical results.

4.2 Off-Tract Facilities Description

4.2.1 Grand Junction Office

No change in 1984.

4.2.2 Grand Junction Laboratory

This laboratory, which is located approximately 4 miles west of the Grand Junction Horizon Court office, analyzes shale, gas and water samples for the Cathedral Bluffs site. Routine samples are analyzed and reported within 3 to 4 weeks after receipt. Tests started in mid 1983 were continued during 1984 on pond liner materials to determine their stability.

In early November this laboratory was closed; its functions were allocated to consulting laboratories. Essential equipment was then relocated to the Cathedral Bluffs field site.

4.2.3 Rifle Warehouse and Rail Siding

No change in 1984.

4.2.4 Rifle Parking Lot

No change in 1984.

4.2.5 Utility Corridors

No change in 1984.

4.3 Access/Service/Support Activities

4.3.1 Fuel Storage and Dispensing

The Fuel Dispensing Facility, which is computer controlled, was put into service in 1981. It is designated as Facility #16 on Figure 4-2. Gasoline, as well as diesel fuel, are piped into the dispensing system. Liquid petroleum gas storage tanks are also located around the site to provide gas for heating the site's buildings and facilities. Natural gas service to the site was expanded in 1984 and now supplies the generator building, shop building, and the mine air heaters. Fuel consumption during the year was 5,383 gallons of #2 diesel, 13,422 gallons of gasoline, 99,239 gallons of LPG and 1255 million cubic feet of natural gas. Consumables use is summarized for 1984 in Table 4-3.

TABLE 4-3

1984 CB Consumables Usage

	USE	UNITS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL YTD	TOTAL YRS TD
WTR TREATMENT-ACID	POND A&B	10**3 GAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		115.97
DIESEL FUEL #1	-	10**3 GAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		69.01
DIESEL FUEL #2	-	10**3 GAL	.27	.41	.05	2.00	.65	1.19	.20	.12	.03	.05	20	.21	5.38	452.78
GASOLINE	-	10**3 GAL	1.14	1.30	1.09	1.36	1 19	1.11	98	1.07	1.01	99	1.11	1.06	13.42	309.32
PROPANE	-	10**3 GAL	22.58	12.09	9.28	6.61	20.66	.00	.00	.00	2.07	.00	14.03	11 91	99.24	591.74
NATURAL GAS	-	10**3 MCF	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.25	1.25	787.21
DUST PALLIATIVE	-	10**3 GAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		32.97
MINED SHALE	-	10**3 CU YD	.00	.00	.00	.44	.17	.00	.00	.00	.00	.00	.00	.00	62	116.15
MINED SHAFT ROCK	-	10**3 CU YD	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		11.40
EXPLOSIVES	-	10**3 LBS	.00	.00	.00	1.50	.50	.00	.00	.00	.00	.00	.10	.00	2.10	331.62
EXPLOSIVES FREQ.	-	10**3	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.01	1.57
DISTURBED ACREAGE	-	ACRES	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	191.00
FLOCCULANT	-	10**3 GAL	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00		1.55

4.3.2 Pipelines

A major addition to the natural gas pipeline was installed on-Tract from the existing line near the generator building to the mine air heaters and maintenance shop. See Figure 4-7. This pipeline will replace the need for propane gas for these facilities and the generators. Natural gas service was resumed at the site following completion of the new line.

4.3.3 Surface Mobile Equipment

A fleet of mobile surface maintenance equipment is maintained to service the needs around the site. This work includes loading and unloading supplies, road maintenance and repair, pond construction and repair, construction of erosion control structures, and snow removal in winter.

4.3.4 Communications

Repairs and maintenance work was done on an as-needed basis on the mine phone communications system. Paging telephones are installed at each station in the Service Shaft, the Control Room, the Mine Shop, the elevators in the Service and Production Headframes, the Mine Rescue Trailer, and the Mine Support Area Substation.

4.3.5 Other Service and Support Activities

Other service and support activities relate to:

(1) roads and guard rails;
(2) truck weighing facility;
(3) sewage treatment facility;
(4) pump gland seal water system;
(5) fire water system;
(6) helicopter pad; and
(7) aerial survey.

There was no additional work performed on these areas during 1984.

FIGURE 4-7 Natural Gas Pipeline On-Tract Construction - 1984

4.4 Mining

4.4.1 Production, Service, and Ventilation/Escape Shafts

During 1984, work in the Production and Service Shafts was limited to maintenance and repairs. Lighting was improved on all levels; mine power centers were repaired and returned to service; electrical ground wires were replaced on major equipment; and other minor electrical repairs were completed. Maintenance on the mine water pumping system was the most extensive work, with constant changeouts of pumps for repair, and repairs to piping. The water rings in the shafts were cleaned; and rain protection coverings were installed over hoist controls and electrical power switching facilities. There was no maintenance work performed in the V/E Shaft.

4.4.2 Production/Service Shaft Station Development

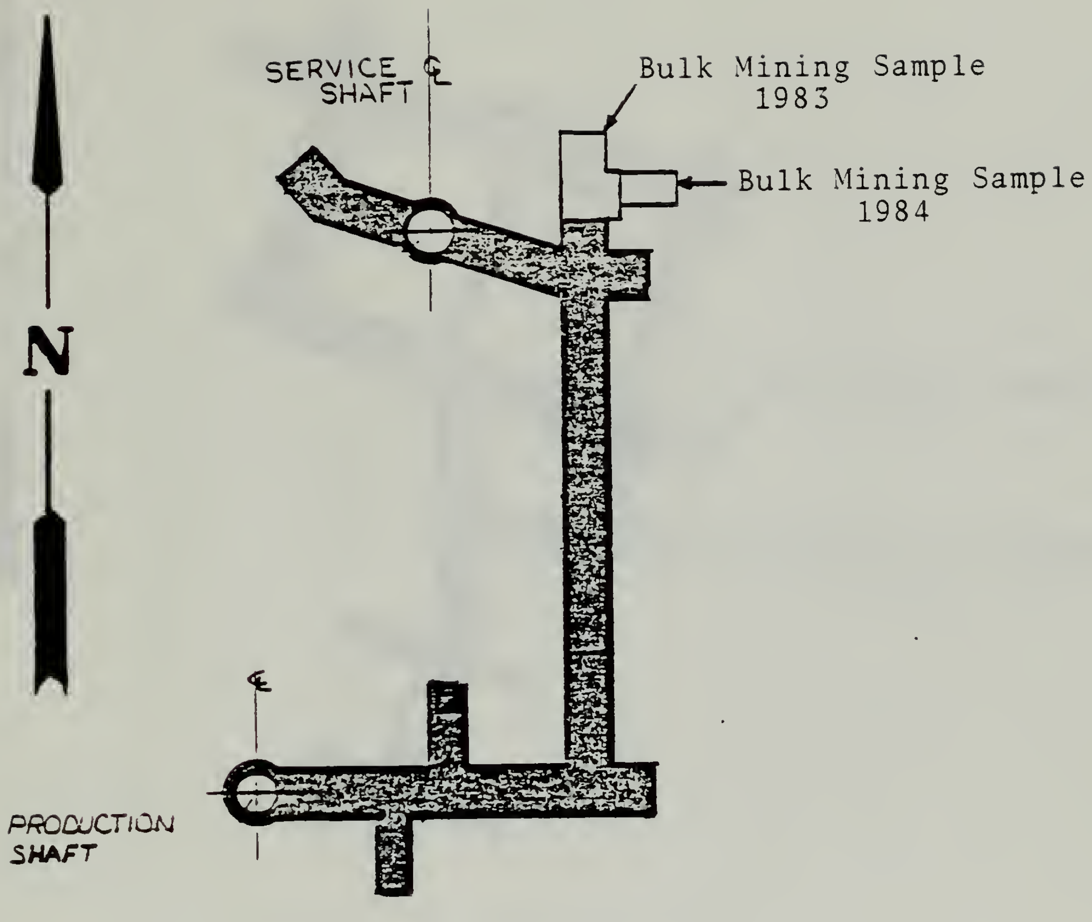
Previous Production and Service Shaft station development illustrating the dewatering pumping system appeared in the 1981 CB Annual Report on Figure 4-37.

A bulk sample of oil shale was mined in 1984 on the upper and lower level stations (see Figures 4-8 and 4-9). Approximately 450 tons of rock on the upper level and 350 tons of rock on the lower level were mined. The upper level rock containing 45 gpt mixed with the lower level rock containing 20 gpt yields a product of 37 gpt. This material is consistent with grades used to test the Union pilot retort with CB run-of-mine grade rock. The rock was crushed and screened with the feeder breaker and gyrotory crusher to reduce it to feed size for the Union pilot retort.

Additional mining was done on the lower level in the underground electrical equipment room drift (see Figure 4-9). Approximately 300 additional tons of rock were removed from the walls and floor to allow sufficient space for electrical equipment and loading pocket controls, which will be installed at a later time.

4.4.3 Mine Ventilation

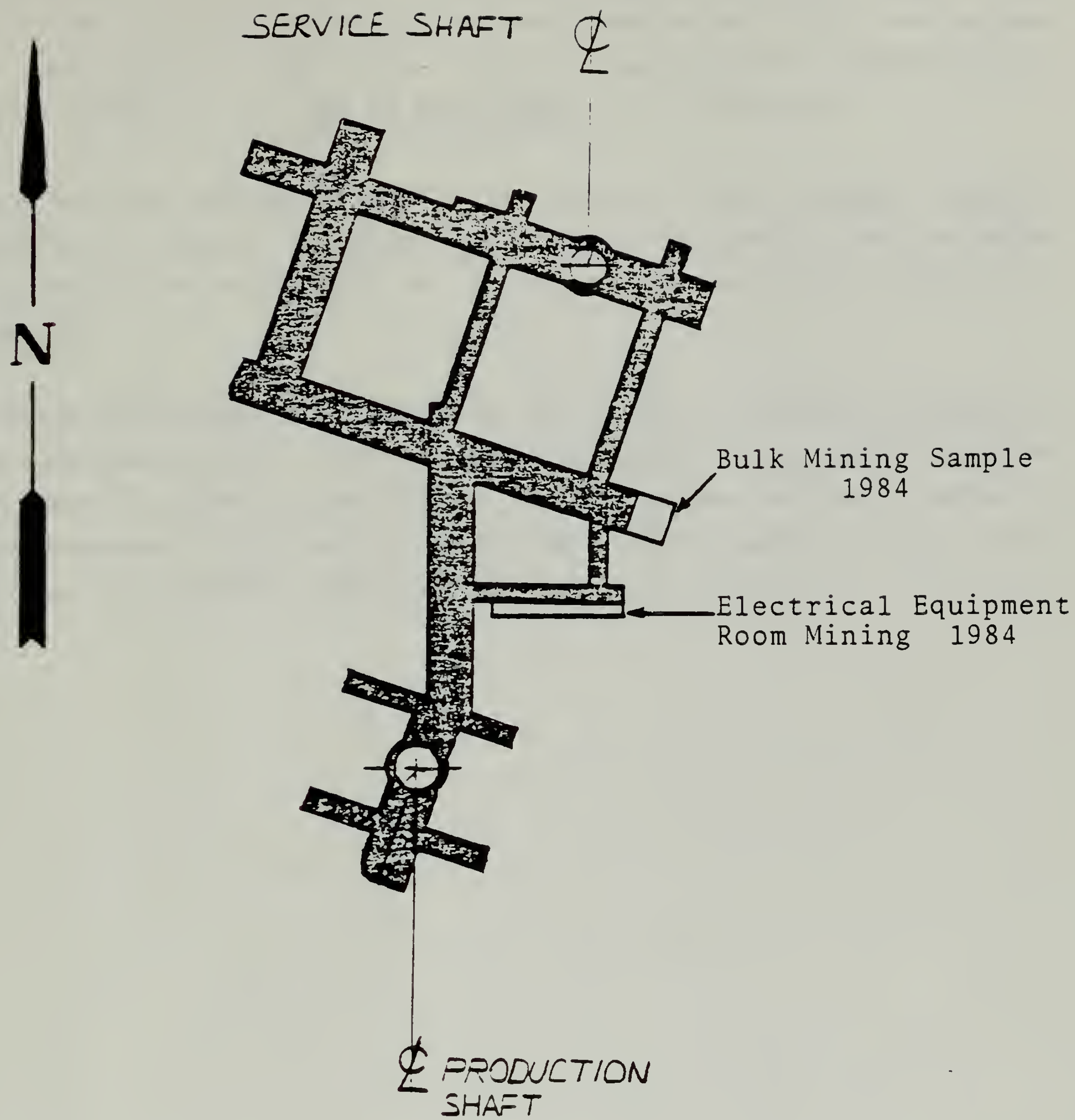
Main mine ventilation is provided by a 75-hp fan on the surface, equipped with a heater, pushing fresh air down the Service Shaft and exhausting up the Production Shaft. Ventilation is controlled on the levels by means of airlock



Scale 1" = 100'

FIGURE 4-8

<u>Upper Level Station Plan View</u>
<u>Showing 1983 and 1984 Bulk Mining Samples</u>



Scale 1" = 100'

FIGURE 4-9

Lower Level Station Plan View
Showing 1984 Bulk Mining Samples and Electrical Equipment Room Mining

doors and regulators to give the required ventilation across each level. The Production and Service Shaft bottoms are ventilated by twin 50-hp fans located on the lower level. A ventilation schematic showing airflow quantities and directions appeared in the 1981 CB Annual Report on Figure 4-38.

Work that was done on the ventilation system in 1984 included: changing the propane-fired heater to natural gas; repairs on controls and recording devices; repairs on the surface fan; and remodeling the access platform for safer access.

Routine maintenance and calibration of the mine monitoring system and sensors continued in 1984. This system was completed in 1983 and is equipped with 26 sampling points to continuously monitor methane gas concentration in the mine atmosphere (Table 4-4) and another 46 points to monitor functions such as air flow, fan operation, pump operation, and water levels.

TABLE 4-4 Methane Monitoring Locations

Level	Location
Surface	Mine Air Exhaust at the Production Shaft
Midshaft	Electrical Vault
Midshaft	Sump
Midshaft	Main Drift at the Production Shaft
Midshaft	East Rope Drift at the Production Shaft
Midshaft	West Rope Drift at the Production Shaft
Air	Drift West of Service Shaft
Air	Ore Pass Drift
Air	Main Drift at the Production Shaft
Upper Void	Drift West of Service Shaft
Upper Void	Ore Pass Drift
Upper Void	Sump
Upper Void	Main Drift at the Production Shaft
Upper Void	Mining Sample Drift
Intermediate Void	Drift West of Service Shaft
Intermediate Void	Ore Pass Drift
Intermediate Void	Main Drift at the Production Shaft
Lower Void	Electrical Vault
Lower Void	Sump
Lower Void	Main Drift at the Production Shaft
Lower Void	Service Shaft Ventilation Tubing
Lower Void	Northeast Conveyor Drift
Lower Void	Northwest Conveyor Drift
Lower Void	Southeast Conveyor Drift
Lower Void	Southwest Conveyor Drift
Lower Void	Drift South of Production Shaft

5.0 PROCESSING

No shale oil processing facilities exist on the C-b Tract. Engineering studies related to processing are discussed in Section 4.1.13.

6.0 LAND DISTURBANCE AND RECLAMATION

The major reclamation activity of 1984 was the preparation of a draft for a new CB Mined Land Reclamation Permit Amendment Application. Tests were conducted on CB shale retorted via the Unishale B retorting process. These tests include further characterization of the spent shale and the hydrologic properties of the proposed spent shale embankment. They are deemed necessary to further define the proposed design of the spent shale disposal embankment. The test results will be supplemental as necessary to accompany a 1985 submittal of the amendment application to the Colorado Mined Land Reclamation Board. Further testing of the selected AGR processed shale will probably be required and incorporated into the submittal.

In August 1984, the CB staff constructed a second revegetation demonstration plot. Approximately 90 tons of Union B and 40 tons of Lurgi processed shale were covered with 12" of topsoil. A lysimeter was installed in each of the three treatments. The plot was seeded in October 1984. This plot is discussed in more detail in Section 9.3.10.2.2.

Areas of disturbance through 1984 and the corresponding estimated acreages are listed in Table 6-1. No new areas were disturbed in 1984 so that the disturbed acreages shown on Figure 6-1 of the <u>1983 CB Annual Report</u> still apply.

6.1 Disturbed and Reclaimed Areas

The areas reclaimed during 1984 consisted of the six drill pads of the 1983 core sampling program. The coreholes are designated as 21Y-12, 21Z-12, 41X-12, 44X-1, 43X-1 and 14X-6. Each of the drill pads are approximately one-half acre in size, for a total of three acres. The total disturbed acreage to date is 191.

Two of the six coreholes have been converted to monitoring wells. The 1983 recompletion was not satisfactory on four of the wells. The other four wells are scheduled for completion in 1985. Drill pad 44X-1 was seeded but not recontoured as this would limit future recompletion work; also, deep soils provide adequate seedbed material without recontouring. The other five drill pads were recontoured prior to being seeded.

TABLE 6-1

Estimates of Acreages Disturbed and Revegetated

Area[1]	Acreages Disturbed Before 1984	Acreages Disturbed During 1984	Acreages Revegetated Before 1984	Acreages Revegetated During 1984
1) Guard House & Truck Scale Area	2			
2) Sewage Treatment Plant & Road	2			
3) Heliport & P. R. Trailer	1			
4) Main Access Road	24			
5) V/E Shaft Area	14			
6) Proposed Dam Site (East No Name Gulch)	3		3	
7) Fill Material Area	12			
8) Explosives Storage	2			
9) Mine Support	73			
10) Raw Shale Embank.	12		1	
11) Rock Stockpiles	4			
12) Topsoil Stockpiles	13		11	
13) Water Discharge & Application Area	4			
14) Abandoned Access Road	10		10	
15) Permitted Areas				
16) Irrigation Pipeline	4		4	
17) Pond "C" Pipelines	2		2	
18) Drill Pads & Roads	9	0	4	3
19) Raw Shale Demonstration Plot				
20) Processed Shale Demonstration Plot				
TOTALS	191	0	35	3

[1]Numerated Areas in column correspond to numerated areas on "C-b Tract Map" #AD-0039 Rev. 4, 1984, Figure 6-1 (jacket map) of the 1983 Annual Report.

As a result of drill pad reclamation in 1984, the total acres reclaimed during 1984 was three. This raises the total number of acres reclaimed to date to 38.

6.2 Stockpile and/or Disposal Activities

Approximately 800 tons of raw shale were mined and crushed at the C-b Tract in 1984. From this a 600 ton sample was sent to outside locations for retorting and characterization. The remaining 200 tons are presently stockpiled on the foundation of the future warehouse in the Mine Support Area. CB received approximately 90 tons of spent shale processed via the Unishale B Pilot Plant in Brea, California. This test run was conducted in late 1983 and early 1984 from raw shale samples mined in 1983.

This was the only mining activity to occur at the C-b Tract in 1984. The amounts of mine overburden, raw shale, and spent shale which are either stockpiled or disposed have not changed significantly during 1984, with exception of the new demonstration plot and raw shale (approximately 200 tons) stockpiled on the warehouse foundation in the Mine Support Area. There was no increase in acreages of disturbance in 1984.

6.3 Disturbance/Reclamation Status

6.3.1 Graded Areas

The six corehole drillpads were reclaimed; and, since no new areas were disturbed, the total area presently in a graded condition decreased to 136 acres.

6.3.2 Topsoil Stockpiled

There was no change in stockpiled topsoil volumes and acreages during 1984.

6.3.3 Topsoil Replacement

Five drill pads were recontoured with topsoil from the pads. This did not change the topsoil acreages in stockpiles.

6.3.4 Revegetation

Six drill pads were revegetated in 1984.

6.4 Reclamation Management

Except for the six drill pads and the 1984 demonstration plot previously discussed, no new areas were seeded, mulched, irrigated, fertilized, or fenced in 1984. A small scale (less than 20 plants) transplanting test was initiated in late 1984 on the topsoil stockpile west of the access road near NPDES discharge point 001. Percent survivability of these transplants will be recorded in future years. The topsoil stockpiles were evaluated for cover, production, and species composition. Data from sampling are presented in the January, 1984 Data Report, and analysis of the data is discussed in Section 9.3.10 of this report.

6.4.1 Associated Costs

The associated cost for reclamation during 1984 was the labor involved in sampling and analysis of data, for labor and material cost for reclamation of the six drill pads, the processesd shale demonstration plot, and transplanting test. The approximate total cost for reclamation was $15,000.

7.0 ENVIRONMENTAL PROTECTION AND CONTROL

7.1 Air Pollution Control and Visibility

Principal activities in 1984 with the potential to affect air quality included vehicle transport along access and haul roads, and infrequent but permitted open burning.

Comparisons of air monitoring measurements with ambient air quality standards are made in Table 7-1; compliance with these standards was achieved in 1984.

Air pollution permit conditions require use of control equipment and specified operating procedures. Permit status is summarized in Section 7.11 in tabular form showing permit purpose, agency, permit number and approval date. CB is in compliance with all air permits.

CB holds a Prevention-of-Significant-Deterioration (PSD) Permit for the Ancillary Phase of MIS operations (defined in 1977 as up to 5,000 barrels/day nominally) from the EPA (Merson, 1977). Approval of an amendment to incorporate aboveground retorting and oil upgrading for a total capacity of 13,500 bbls/calendar day was received from the EPA in September, 1983 (Duprey, 1983). A draft amendment to the 1983 permit to update MIS operations, emissions and control systems is being prepared.

The CB project obtained a Fugitive Dust Permit (C-11,454) (FD) from the Colorado Air Pollution Control Division in 1977, revised in 1980. Pursuant to this permit, CB paved the major access road to the Tract. This work was completed in August of 1978. PSD and Fugitive Dust Permits require dust control on haul roads by regular applications of water and dust palliatives. Water has been applied to the haul roads on an as-needed basis; dust palliatives have been applied as needed. The applications of both water and dust palliatives are indicated in Tables 4-2 and 4-3.

In 1981, a permit was issued by the State of Colorado for a feeder-breaker to crush oil shale rock to minus 8-inch size. Maximum throughput is limited to less than 1,000 tons per hour and annual throughput is limited to 70,000 tons.

Table 7-1

Comparisons of Maximum Background Levels with National Ambient Air Quality Standards (Station AB23)

Time Period	Constituent	Standard Limit Primary	Standard Limit Secondary	Baseline Period 11/74-10/76	1977	1978	1979	1980	1981	1982	1983	1984
	Averages (ug/m^3)											
Annual	SO_2	80.0		1.0[a]	0.3	1.3	0.4	1.0	1.5	1.4	1.8	1.0
	NO_2			1.5[a]	0.9	0.0	2.0	1.0	10.3[b]	2.7	1.3	3.6
	Particulates[c]	75.0	60.0	11.2[a]	6.7	9.1	13.3	7.0	10.2	7.5	6.5	4.6
	Max. Concentration (ug/m^3)											
1-hour	CO	40,000.0		3539.0	1530.8	4200.0	2900.0	3800.0	1800.0	600.0	140.0	241.5
	Oxidant (O_3)	235.[d]		152.	164.	161.	246.[e]	154.	155.	143.	135.	135.
3-hour	SO_2		1300.0	88.0	17.6	24.0	16.4	13.1	18.3	15.7	13.9	12.2
8-hour	CO	10,000.0		2894.0	816.8	4000.0	1700.0	3000.0	1800.0	200.0	115.0	50.
24-hour	SO_2	365.0		43.0	11.5	15.0	7.6	11.9	17.3	13.0	10.7	10.7
	Particulates	260.0	150.0	171.0	74.0	64.1	99.8	58.4	86.2	51.4	46.9	28.5

[a] Highest annual average during baseline period.
[b] <50% data.
[c] Geometric mean.
[d] Standard is exceeded if the number of exceedances of hourly values is $\geq$ 3 in a 3-year period.
[e] Only 1 value >235 to date.

Water spray bars are utilized as the approved emission control devices. No PSD permit was necessary from the EPA since the annual emission level does not exceed the de minimis level of 25 tons of dust per year (based on an emission factor of 0.1 lb. of dust per ton of rock); emissions from this operation will be included in the next PSD permit amendment. The feederbreaker was used in 1984.

With regard to visibility protection, no specific visibility-related regulations have been promulgated by the EPA although a task force has been established by EPA to develop a long-term strategy for dealing with visibility impairment. Visibility monitoring has been conducted since 1975, under request of the OSPO. No significant degradation in visual range has been noted since the inception of this program. Mean visual range remains in the neighborhood of 80 miles.

7.2 Water Management and Augmentation

The physical description of the water treatment facilities is given in Section 4.1.10. In 1984 discharge into Piceance Creek from Ponds A/B via East No Name Gulch under NPDES permit was the only part of the facilities utilized.

Table 4-2 summarizes water usage by month; annual and cummulative annual values are also shown. Water treatment rates (gpm) are further summarized on Table 7-2.

Regarding compliance with the NPDES permit criteria, effluent limitations under the new (1983) permit (Colorado Department of Health, 1983, 1984) are shown on Table 7-3. The Colorado Water Quality Control Commission did not specify a permit limitation for fluoride in the new permit (as required under the previous permit) since they did not judge it necessary to protect stream uses or stream standards for fluoride. In 1984, excursions under the permit were reported to the State as follows:

Parameter	No. of Excursions Daily Max.	30-day Avg.
Mercury	7	1
Cadmium	2	0

The high mercury values were apparently due to a broken mercury thermometer in the laboratory in July which contaminated subsequent samples. Sampling protocol was changed in mid-November to by-pass the contaminated lab. The high cadmium values are possibly due to contamination from action of reagents on cardboard in the sample-bottle cap. Sampling protocol alternatives are under study.

TABLE 7-2
Summary of Water Pumped and Used (gpm)

Year	Month	Water Pumped From Mine	Water Used, Stored, Evaporated	Water Treated[1]			
				NPDES Discharges	Sprinkler (Land Application)	Reinjection	Total
1981	January	1,645	341	1,304	-	-	1,304
1981	February	1,663	596	1,067	-	-	1,067
1981	March	1,392	498	754	-	140	894
1981	April	1,122	278	583	-	261	844
1981	May	1,636	466	1,109	-	61	1,170
1981	June	1,221	136	745	48	292	1,085
1981	July	1,582	467	739	339	37	1,115
1981	August	1,550	275	942	326	7	1,275
1981	September	617*	180	293	39	105	437
1981	October	627	184	8	-	435	443
1981	November	660	205	16	-	439	455
1981	December	772	298	-	-	474	474
1982	Janaury	664	181	-	-	483	483
1982	February	651	154	5	-	492	497
1982	March	535	90	-	-	445	445
1982	April	476	60	-	-	416	416
1982	May	663	87	-	-	576	576
1982	June	588	83	-	-	505	505
1982	July	560	20	540	-	-	540
1982	August	562	22	540	-	-	540
1982	September	532	7	525	-	-	525
1982	October	472	0	472	-	-	472
1982	November	460	2	458	-	-	458
1982	December	495	0	495	-	-	495
1983	January	475	8	467	-	-	467
1983	February	462	11	451	-	-	451
1983	March	467	9	458	-	-	458
1983	April	461	11	450	-	-	450
1983	May	448	1	447	-	-	447
1983	June	442	13	429	-	-	429
1983	July	442	45	397	-	-	397
1983	August	423	39	384	-	-	384
1983	September	421	41	380	-	-	380
1983	October	423	42	381	-	-	381
1983	November	416	19	397	-	-	397
1983	December	405	31	374	-	-	374
1984	January	401	21	380	-	-	380
1984	February	410	26	384	-	-	384
1984	March	392	25	367	-	-	367
1984	April	389	30	359	-	-	359
1984	May	379	26	353	-	-	353
1984	June	390	40	350	-	-	350
1984	July	387	66	321	-	-	321
1984	August	385	76	309	-	-	309
1984	September	378	59	319	-	-	319
1984	October	369	74	295	-	-	295
1984	November	361	58	303	-	-	303
1984	December	359	56	303	-	-	303

(*Starting September 1, 1981 V/E Shaft was no longer pumped and allowed to fill)
[1] Water Pumped = Water Used + Water Treated

[illegible]

TABLE 7-3

Effluent Limitations for the 1983 NPDES Permit

(Outfall 002, Ponds A or B)

Effluent Parameter	Maximum Concentration (mg/l) 30-day Average	Maximum Concentration (mg/l) Daily Maximum
Total suspended solids	30	45
Total dissolved solids	1,700	2,500
Total boron	2.0	3.0
Total ammonia as nitrogen	2.4	N/A(2)
Total iron	11.0	22.0
Total cadmium	0.05	0.10
Total copper	0.04	0.08
Total mercury	0.00005	0.0001
Total silver	0.00053	0.0011

Oil and grease shall not exceed 10 mg/l in any grab sample nor shall there be a visible sheen. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units. There shall be no discharge of floating solids or visible foam in other than trace amounts.

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(2) Weekly max 3.6

In 1983 the Colorado Water Control Commission classified Piceance Creek and adopted stream standards for its various reaches (Stewart, 1983). The reach of Piceance Creek near the C-b Tract (between Stewart Gulch on the east and Hunter Creek on the west) has been classified: Class II, Aquatic Life, Warm Water and Class II, Recreational and Agricultural. Comparison of Piceance Creek water quality with these stream standards is shown in Table 7-4.

Highlights of the CB Water Augmentation Plan (State of Colorado Water Court, 1979) were given in the 1980 report. To the present time no water depletions have occurred nor has augmentation by CB been required by the State Engineer or senior rights holders.

7.3 Oil and Hazardous Substances and Associated Spill Contingency

The Spill-Prevention Control and Countermeasure Plan includes a description of the potential for accidental spills or release of oil as a result of the Lessee's development of the Tract and associated off-Tract pipelines and terminals. This plan summarizes the potential sources of accidental spills, reviews the current regulations and standards that would apply to the Lessee's activities, and presents the Lessee's Spill-Prevention Control and Contingency Plans for the plant and associated pipelines. A more detailed plan will be developed prior to production of commercial quantities of shale oil and possible hazardous wastes.

For spills of toxic or hazardous material, temporary containment materials have been purchased to build dams and barriers. Clean-up and containment kits are stored in the Emergency Vehicle Building. Instructions have been made available to employees in each shift crew.

7.3.1 Summary of Potential and Actual Spills During Construction

During construction activities, spills of diesel fuels and other fuels and lubricants are possible during transportation, loading, and unloading operations, both on-Tract and at construction staging areas and rail spurs. Dust suppressants and smaller amounts of miscellaneous chemicals used during construction activities also pose pollution threats if quantities of these materials reach drainages or flowing streams near the Tract. The trucking,

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 7-4

Comparison of Piceance Creek Water Quality with Stream Standards (mg/l)

Parameter	Stream Standard (a)	Highest 1984 Value October 1983 - September 1984)	
		Station 9007 (Upstream of Tract)	Station 9061 (Downstream of Tract)
Ammonia (Un-ionized)	0.1	0.1	0.05
Boron	4.0	0.18	0.17
Cadmium	0.05	<0.001	<0.001
Chlorine (residual)	0.003	(b)	(b)
Chromium (tot)	0.1	(b)	(b)
Chromium (hex)	0.025	(b)	(b)
Coliforms, Fecal	2000/100 ml	930(c)	430(c)
Copper	0.04	0.005	0.004
Cyanide	0.005	No value	No value
Dissolved Oxygen	$\geq$5.0	13.0	12.4
Iron (tot)	11.0	(b)	(b)
Lead	0.10	0.002	0.002
Manganese	1.0	(b)	(b)
Mercury	0.00005	<0.0001	<0.0001
Nickel	0.2	(b)	(b)
Nitrite	0.5	No value	No value
pH (non-dimen)	6.5 - 9.0	8.7	8.7
Selenium	0.05	0.005	0.003
Silver	0.00053	(b)	(b)
Sulfide, Hydrogen	0.002	(b)	(b)
Zinc	0.6	0.006	0.020

(a) Stream Reach: Piceance Creek between Stewart and Hunter Creeks in zone containing outfall CB 002 from East No Name Gulch; from Stewart (1983).

(b) Not required under CB monitoring program.

(c) Results based on colony count outside the acceptable range (non-ideal colony count).

[illegible]

loading, and unloading of fuels and chemicals during construction is a potential source of accidental spills. A program has been implemented to ensure that future transformers brought on Tract will not contain PCB's.

There were no reportable spills (see 7.3.3) requiring activities of the Spill Contingency Plan during the year.

7.3.2 Oil and Hazardous Substance Inventory

A list of oil and hazardous substances presently on-Tract is given on Table 7-5. The list identifies those both on- and off-Tract which would be classed as wastes if allowed to escape; locations are cross-referenced to maps in this report. Storage is consistent with Lease requirements.

7.3.3 Notification Under the Response Plan

In the event of an accidental spill of oil or hazardous substance in quantities greater than those specified by the regulations, various governmental entities must be notified. Spills consisting solely of oil are reportable when they reach or have the potential of reaching a waterway in quantities which cause a film, sheen or discoloration of the water. Spills involving hazardous substances are defined to be reportable when they occur on the land or reach a waterway in quantities exceeding those specified by the regulations (40 CFR 117.3).

Notification	Spill Situation
National Response Center (NRC)	"Reportable Spills"
Regional Response Center	When the NRC cannot be contacted
Colorado Department of Health	"Reportable Spills"
Colorado Division of Wildlife	Danger to fish, etc., in surface water supplies
Water Quality Control Division Colorado Department of Health	Contamination of water supplies
Colorado Highway Department	Move vehicles, control traffic
Oil Shale Project Office	All spills
BLM, USFS, Downstream water users	Certain cases
Local, city, fire, police, health departments	Major spills

TABLE 7-5

Oil and Hazardous Substance Inventory

Material Stored	Storage Site No.**	1979 Storage BBL	1980 Storage BBL	1981 Storage BBL	1982 Storage BBL	1983 Storage BBL	1984 Storage BBL
Plasticrete	15	50	50	90	1	1	1
Diesel Fuel	16	830	2,950	3,000	1,500	250	350
Gasoline	16	35	645	1,000	500	145	180
Motor Oil and Grease	*	0	0	70	50	20	18
Chlorine	15	10	10	0	0	0	0
LPG	*	190	850	837	595	305	300
Shale Oil	40	0	0	244	0	0	0
Sulfuric Acid	43	30	100	100	24	20	20

* Stored at numerous locations on construction site.

** See Figures 4-2 and 4-3.

7.3.4 Spill Response Team

All spills are the responsibility of an in-plant spill response team which will be especially organized and trained for this purpose. A Spill Response Coordinator (SRC) has the primary responsibility for deciding the action required and assembling the necessary team elements (see Table 7-6).

7.4 Waste Disposal

The 9,000 gallon-per-day sewage treatment facility was not in operation during 1984. At present, the sewage is being disposed via porta-johns; and an approved sewage system that has been in operation for nine years is utilized to dispose of that from the C-b offices. Solid waste (trash) accumulated in waste bins was trucked off-site as frequently as necessary to an approved landfill in Meeker; total amount for 1984 was approximately 325 cubic yards.

7.5 Erosion Control

Nine erosion basins, constructed prior to 1984, remain at C-b Tract controlling run-off from disturbed sites. Sediment was mucked out of these structures during 1984. They were monitored throughout the year and no leaks or any visible sign of oil were detected.

A heavy rainstorm on August 1 caused three of these erosion control basins to overflow and a storm on August 16 caused the largest basin to overflow. These basins have subsequently been pumped to preclude future overflows. These basins are all sized to contain the required design storms with the exception of the largest basin; it is planned to be enlarged and modified in 1985.

Seven erosion/stock-watering basins were constructed in October 1984 per request of livestock manager, R. Oldland, and per approval of the OSPO. Additional work to seal and construct a spillway on the side so that overflow can exit on each contour ditch will be performed in the early spring of 1985.

7.6 Historic, Scientific, and Aesthetic Values Protection

As part of the Lessee's plan to protect these assets, archaeological and scenic-value studies have been undertaken on the Tract and surrounding area and reported in prior years; in 1984 no new studies were conducted or needed. In view of the relatively light Tract activities in 1984 no archaeologic "findings" were expected, nor reported.

TABLE 7-6

Spill Response Team Members

Spill Response Coordinator	S. L. Stringer
Cleanup Coordinator	S. L. Stringer
Government Liaison Coordinator	E. B. Baker
Public Relations Coordinator	R. E. Thomason
Legal Coordinator	J. M. Badger
Environmental Protection Coordinator	E. B. Baker
Procurement and Logistics Coordinator	T. L. Carruthers
Document Coordinator	T. H. Pysto
Accounting Coordinator	T. L. Carruthers
Training Coordinator	K. Morgan
Safety and Security Coordinator	J. E. Shaler

7.7 Health, Safety and Security

7.7.1 Program and Services

7.7.1.1 General

CB management is committed to maintain a safe working environment for all employees. Although all risks cannot be completely eliminated, CB will provide and maintain working conditions which are as safe and healthful as modern state-of-the-art safety and industrial hygiene practice can provide. A comprehensive health, safety, and security program is in place and will be expanded to ensure that these objectives are achieved. New employees are required to receive health and safety training prior to being assigned work duties.

Currently the Health and Safety Department staff consists of three (night) security guards at the C-b Tract. Three trained Emergency Medical Technicians remain on the CB staff for emergency treatment. St. Mary's Flight for Life aircraft helicopter is available for extreme medical emergencies twenty-four hours a day.

7.7.1.2 Manhours/Accident Frequency Rate

Following are figures depicting the manhours and accident frequency rate for 1984 at the C-b Tract:

	Manhours	Reportable Accidents	Incident (a) Rate
CB	36,353	0	0
Contractors	10,306	4	77.62
TOTAL	46,659	4	17.15

This rate is high due to the relatively high number of accidents coupled with the low number of manhours. A program to reduce this incident rate is underway through training, job safety analysis and conduct of frequent safety meetings.

(a) $\text{Incident Rate} = \frac{\text{No. of Reportable Accidents} \times 200{,}000}{\text{Hours of Employee Exposure}}$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

7.7.1.3 Inspections and Violations

Cathedral Bluffs had a total of seven MSHA inspection days during 1984; there was one State Division of Mines inspection day. There were no citations received during 1984.

7.7.2 Possible Health Hazards

7.7.2.1 Dust

Dust is controlled on unpaved sections of roadways by the application of water and/or dust suppressant on an as-needed basis. Dust is controlled during rock drilling operation by the use of water. Although there have been no surveys conducted yet to determine full-shift mine employee exposure to dust, it is not anticipated that problems exist in this area. Were dusty conditions to be encountered, the condition would be mitigated by changing ventilation, use of water sprays, or a dust palliative. Respirators would be used if compliance with standards could not be otherwise achieved.

7.7.2.2 Noise Control

Occupational noise control for employee protection is accomplished where feasible by equipment design. When this approach is not feasible, or when engineering design does not reduce noise levels below the maximum allowable limit, all exposed persons will be required to wear ear protection.

7.7.3 Fire Control

Fire control training has been provided for both surface and underground situations.

The fire control systems utilized at the C-b Tract include the following:

- Dry chemical hand-held and wheeled fire extinguishers for protecting all buildings, including headframes.
- A twin agent (dry chemical/water foam) trailer extinguisher for large fire protection.
- A portable water tank (trailer mounted) available for use in extinguishing brush fires that might develop on site.

7.7.4 Gas

The mine was classed as gassy on January 2, 1980 by the Mine Safety and Health Administration (MSHA). During 1984, methane was checked on a continuous basis by use of a mine monitoring system which has stations throughout the mine levels (Table 4-4). Logs of that activity are kept on site. Samples of the mine atmosphere for gas chromatograph analysis were taken intermittently throughout the year. No hazardous concentrations of methane were detected during 1984.

7.7.5 Explosives Handling and Storage

Explosives needed for mining and surface construction use are stored in remotely located surface magazines (facilty #63, located on Figure 4-6) which meet the criteria of the appropriate regulatory agencies. Explosives handling and transportation from magazine to the work site are conducted only by experienced, trained workers. Damaged and outdated explosives are burned in a remote location on Tract by the safety personnel under appropriate permit or returned to the explosives' dealer for proper disposal.

7.8 Fish and Wildlife Plan

7.8.1 Objectives of the Fish and Wildlife Plan

In 1984 the plan was reviewed and mitigation projects were implemented. The projects initiated were the experimental seeding on south-facing slopes and the serviceberry brush beating.

7.8.2 Mitigative Actions

7.8.2.1 Sagebrush Beating

Success of the sagebrush beating program has been evaluated the past 3 years with no evidence obtained for increased numbers of deer (higher pellet-group densities) in brush beaten areas. The same analysis (2-level ANOVA*) was again conducted this year (Table 7-7). Again, differences between treatment and control areas were nonsignificant ($F = 0.29$; $df = 1,7$; $P > 0.50$). The

*ANOVA = Analysis of Variance

significant F value of 9.06 in Table 7-7 refers to the differences among the control plots.

For the past 3 years, comparisons have been made of cottontail use between brush beaten and unmodified sagebrush areas. Results to date, including this past year, have consistently shown lower frequencies of cottontail pellets in the brush beaten plots (for 1983-84 $F = 5.58$, $df = 7$, $P<0.001$). Brush beating, therefore, appears to have a negative effect on cottontail populations.

Casual observations noted that deer are using the edges of the brush beaten areas and the side slopes, whereas the cattle tend to remain in the brush beaten areas. Sagebrush density is increasing more rapidly in the Gardenhire beating area than in the Oldland beating area.

7.8.2.2 Serviceberry Brush Beating

The BLM completed the brush beating using C-b's brush-beater in November 1984. Half of the area was chopped by pulling the rollers in tandem, and the other half was chopped with the rollers pulled side by side. The entire test area was seeded using a tractor with a broadcast seeder. The seed mixture was the permanent C-b seed mixture which includes browse species as well as forbes and grasses. The deer pellet transects were reinstalled and swept after the beating was completed. Pre-treatment data have been collected for one year.

7.8.2.3 Deer Reflector Study

Nine deer were killed by vehicles in the reflector area during the 1983-84 period. Only four deer were killed when the reflectors were operational and five when they were covered. This brings the total kill to 31 deer; 19 while the reflectors were covered and 12 when they were operational (Table 7-8). The data seem to favor the hypothesis that the reflectors reduce the number of deer-vehicle collisions. However, the sample size is still too small to test for a significant difference at the 90% confidence level.

It should be noted that several of the deer killed during the three year study period may have been killed during daylight when the reflectors do not work, which could bias the results.

TABLE 7-7 Comparison of Mule Deer Pellet-Group Counts between Brush-Beaten Sagebrush and Control Areas.

TWO-LEVEL NESTED ANOVA*:

Source of Variation	DF	MS	F	Various Components
Between brush-beaten and control areas	1	0.15	0.29	4.9%
Among subgroup plots	7	0.50	9.06	27.3%
Within plots	171	0.06		67.8%

F (0.10; df=1,7) = 3.59 F (0.10; df=7,171) = 1.75

Transect Means +/- SE(n) =

Brush-beaten		Control	
BA41**	35 +/- 13 (20)	BA43	70 +/- 23 (20)
BA42	165 +/- 41 (20)	BA44	255 +/- 34 (20)
BA45	100 +/- 36 (20)	BA47	285 +/- 51 (20)
BA46	125 +/- 27 (20)	BA48	70 +/- 19 (20)
		BA49	40 +/- 15 (20)

* Analysis of Variance
** 4-digit station computer code

TABLE 7-8

Piceance Creek
Deer Reflector Study
February 1982 - May 1984

MILE MARKER

Reflectors	9	13	17	19
ON	4	1	5	2
COVERED	9	3	4	3

DEER KILLED

Reflectors	Male	Female	Unknown	Adult	Fawn
ON	4	7	1	9	3
COVERED	5	13	1	10	9

Deer killed with reflectors ON	= 12	= 39%
Deer killed with reflectors COVERED	= 19	= 61%
Total killed in Test Area	= 31	=100%

7.8.3 Water Development

Seven water catchment basins were build on tract on the two ridges east of Sorghum Gulch. They were built to catch spring runoff and water from summer storms. These basins should provide additional water holes for both livestock and wildlife.

Existing tanks were kept full during early summer and fall.

7.8.4 Deer Radio Telemetry Study

Since 1981, the Department of Energy has been funding a deer radio-telemetry on C-b Tract. The primary objectives of the study are to determine migration pathways, seasonal movements, and mortality of mule deer inhabiting areas being developed as Federal Prototype Oil Shale leasing sites in the Piceance Basin. The following is the abstract from Garrott and White (1984):

> An additional 126 deer were radio collared in December 1983, bringing the total instrumented population to 192 at the onset of winter. All deer showed strong fidelity to individual wintering and summering areas and traveled between these areas along the same routes during each migration. Little variability was observed in the timing of fall migration with most movement occurring during October. Timing of spring migration, however, appears to be correlated with weather and may be delayed up to a month when the winter has been severe. Adult doe winter mortality (1983-'84) was 15% for the C-b Tract population and 19% for the Little Hills population, which is comparable to mortality rates of previous years. Fawns, however, suffered heavy mortality with 95% of the instrumented animals from each area dying during the winter. For the <u>fourth consecutive year</u> coyotes killed approximately half of the radio collared fawns in the C-b Tract area. The extremely high mortality rates were due to an increase in starvation deaths on both areas. Persistent deep snow and extended periods of cold temperatures throughout the winter undoubtedly were responsible for these deaths.

Cathedral Bluffs Shale Oil Company has provided data, manpower and some financial assistance to the study.

7.9 Off-Tract Corridors

Comments on the draft BLM Resource Management Plan (RMP) for the Piceance Basin were sent to the BLM in June 1984. A corridor west then north to the present 8-5/8 inch transmission pipeline owned by Rocky Mountain Natural Gas Company was identified as a potential C-b corridor. A north corridor to the LaSal pipeline corridor is another C-b alternative shown in the RMP. CB will notify the BLM when corridor plans are finalized.

7.10 Abandonment

The Abandonment Plan is contained in Supplemental Material to the Detailed Development Plan Modification submitted July 1977. The plan is still valid. It will be updated in the Revised Detailed Development Plan (RDDP) in 1985.

7.11 Permit Status

A CB Permit Status Report of all required environmental permits and approvals for current and near-term construction operations obtained to date is presented in Table 7-9 including the following categories: air, water, land, and other.

7.12 Environmental Assessments

Tenneco and Occidental maintain a policy which requires annual assessments for environmental compliance. Environmental assessments or systems reviews have been conducted regularly with the following objective:

> The primary objective of a systems review program is to assess and improve the overall protection performance of Cathedral Bluffs Shale Oil Company through periodic appraisal of major operating facilities and support systems from Grand Junction.

The assessment team inspected the CB facility in 1984 and found the operation to be in compliance with all pertinent environmental regulations. At this time the team concluded there are no unreasonable or extraordinary environmental risks as a result of the present operating mode of the site.

TABLE 7-9
CB PERMIT STATUS REPORT
CURRRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Air							
1) PSD	For Ancillary Development of 5000 B/D MIS facility	EPA	N/A	10/17/77	12/15/77	N/A	) Construction commenced 1978, and stopped 5/15/84. Eighteen month period within which to resume construction expires 11/15/85 (EPA letter 1/15/85).
2) PSD Amendment	12,000 B/D AGR 13,000 B/D OUG	EPA	N/A	12/29/82	9/26/83	N/A	)
3) APENs (26)	AGR/OUG Emission Sources	CAQCD	82RB410 (1-26)	12/29/82	10/15/83	N/A	
4) Fugitive Dust Permit	Surface disturbance for construction of shafts & support facilities	CAQCD	C-11,454 (FD)	6/27/77	12/28/77 Rev 8/05/80	Indefinite	
5) Emission Permit	Concrete Batch Plant	CAQCD	C-11,931	5/18/78	6/23/78	Indefinite	
6) Open Burning Permit	Dynamite disposal	CAQCD	1860-0B-0007	2/84	2/84	12/84	Permit has annual renewal requirement.
7) Emission Permits (4)	Natural gas generators	CAQCD	C-12,255 (1-4)	12/04/78	3/15/79	Indefinite	
8) Emission Permit	Feeder Breaker	CAQCD	C-13,244 (FD)	3/06/81	4/20/81 (State) 5/18/81 (EPA)	Indefinite	

TABLE 7-9

CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Water							
1) NPDES	Water discharge to Piceance Creek	CWQCD	CO-0033961	8/19/77 Rev. 6/30/80 New appl. 6/30/82	3/27/79 12/1/80 9/30/83	3/31/88	
2) SPCC	To comply with the Clean Water Act	CWQCD, OSPO, EPA		4/83	Not required	Update required every 3 years	Revision submitted 10/83.
3) Water Augmentation Plan	Depletion mitigation	Water Court	W-3492	8/31/77	5/21/79	Project Life	Detailed plan of augmentation due 4/85.
4) Well Permits (34)	Covers permits for 29 wells and 5 shafts filed under Augmentation Plan for any beneficial use.	State Engineer	W-3493	8/31/77	5/21/79	N/A	
5) Sewage Plant Site Approval	Sewage plant	CWQCD	Site 2852	8/06/80	8/28/80		Site transferred to existing package plant.
6) Sewage Plant	Sewage disposal	CWQCD	Site 2852	9/22/80	11/03/80	Indefinite	

TABLE 7-9

CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Land							
1) Lease	Tract C-b development	BLM	C-20341		4/74	4/96	Annual Report due to OSPO 4/30/85. Annual payment due prior to 3/31/85. Data reports due 1/31 and 7/31. Minimum royalties commence 1985.
2) DDP & MDDP	Lease compliance	BLM/OSPO	N/A	2/77	8/77	Life of Lease	Continuation of IMP approved 1/14/85.
3) Monument Peak Right-of-Way	Microwave communications	BLM	C-25677	7/31/77	10/20/77	10-19-2007	Annual rental payment required 10/19/86.
4) Road Right-of-Way	Construct access road	BLM	C-15827 RW	9/77	1/24/78	Concurrent with C-b Lease C-20341	Ten year term rental payment due for renewal 1/23/88.
5) Notice of Prospecting	Site preparation and shaft sinking activities	CMLRB		3/77	Not Required		
6) Rights-of-Way	Monitoring wells and access roads for SG-18, 19,21,A5A,Federal 2-B, TG2-3,TG2-1,71-3,71-5 and visibility site	BLM	C-36377 (Road ROW) CO-010-P WR-83-16 (Wells)	5/83 7/5/83	6/15/83 Until relinquished	6/15/86	Annual payment required (6/15/86). Added visibility site 1/84.
7) Mined Land Reclamation Plan	Surface disturbance reclamation	CMLRB	77-530	11/07/77	3/23/78	Life of Project	Covers MIS development and 710 acres surface disturbance. Amendment required for AGR spent shale disposal prior to construction of AGR processing facilities. Annual reclamation report and fee submitted 3/22/84. Next fee due 3/23/85.
8) Special Use Permit	Permanent zoning	Rio Blanco County		10/10/78		Indefinite	Follows original DDP, includes AGR. Status confirmed by resolution 7/5/83. Impact analysis is included in 1983 Major Development Permit application for addition to OUG and construction housing. (Submitted 11/15/83)

TABLE 7-9

CB PERMIT STATUS REPORT
CURRENT PERMITS/NOTICES

Permit Title	Purpose	Permitting Agency	Permit No.	Date Submitted	Date Approved	Date of Expiration	Remarks
Land (Cont'd)							
9) Power Utility Corridors	Power lines	Rio Blanco Co. BLM/White River Electric's	#C-26839	6/2/78			138 KVA White River Electric line (constructed) will serve Project. (A White River REA Permit).
10) Water Pipeline/ Tank Site	Proposed pipeline and existing tank site	BLM	C-11323	4/75	5/16/75	5/85	Proof of construction filed 6/80; requires renewal 5/85.
Solid Waste							
Resource Conservation and Recovery Act (RCRA)							
1) Notice of hazardous waste activity	Generate & ship hazardous waste	EPA	EPA ID# COD 000 716530	8/18/80	N/A	N/A	There are no current hazardous waste activities.
Other							
1) Notice to FAA of Proposed Construction	Structures over 200 ft	FAA		8/18/78	None Required	N/A	Proper notification made. No further action needed.
2) Heliport Location	Heliport construction	DOI/OSPO, FAA		11/8/79	N/A	N/A	
3) Radioactive Materials License	Operate neutron moisture probe for soil moisture monitoring of spinkler plots.	Co. Dept. Health	Colo 437-01	5/01/80	6/28/80	6/31/85	Source tested every 6 months. Source tested 9/84.
4) TSCA-Inventory of Chemical Substances	Registration of shale oil	EPA	N/A	4/26/78	N/A	N/A	Shale oil is on the inventory of existing chemical substances.

8.0 SOCIOECONOMIC ACTIVITIES

8.1 Workforce

The total CB Project workforce declined by 27 percent during 1984. At the beginning of the year the CB Project employment totaled 84 persons. A total of 61 persons were employed by the end of 1984, 44 of those located at the main office in Grand Junction and 17 located at the Tract.

8.2 Area Employment and Population

Unemployment in both Rio Blanco and Garfield counties declined substantially during 1984, according to figures published by the Colorado Department of Labor and Employment. The unemployment rate in Garfield County decreased from over 9 percent to 6 percent, while in Rio Blanco County the unemployment rate decreased from 7 percent to 5 percent. Garfield County experienced declining unemployment but a relatively stable total labor force, indicating that population in the county remained stable throughout the year. Rio Blanco County experienced a decline in its total labor force and in its level of total employment, indicating a net decline in population throughout the year.

8.3 Transportation

Traffic counts along major highways in the Project area continue to be much lower than those experienced in 1981, and well below the design capacities of those local roadways.

CB participated as a representative to the advisory committee for the preparation of a Transit Development Program for Garfield County. This program recommends development of a small scale transit program in the near term, but considers the eventual integration of all transportation services in Garfield County.

8.4 Housing

The only housing which the CB Project has retained in the area is the 103 space Kings Crown Mobil Home Park in Rifle. Space in this park is available to the general public.

8.5 Socioeconomic Mitigation

Numerous meetings were held during 1984 with local government jurisdictions affected by the CB Project for the purpose of developing an overall Project Socioeconomic Mitigation Plan.

CB continued to participate in the Cumulative Impacts Task Force, an organization of local government, state government and industry, working to identify the cumulative socioeconomic effects of the energy industry.

8.6 Community Donations

Table 8-1 lists the budgeted contributions made by CB to various community projects in 1984.

TABLE 8-1

Cathedral Bluffs
Contribution Status Schedule
As Of December 31, 1984

	Total for Year
City of Rifle	$ 5,000.00
Rifle Recreation District	500.00
City of Meeker	4,000.00
Flight for Life	2,400.00
Grand Junction Civic Organizations	699.00
Rifle Civic Organizations	288.00
Meeker Civic Organizations	287.00
Hilltop Rehabilitation Center	15,000.00
Garfield County United Way	2,500.00
Mesa County United Way	2,500.00
Pioneer Hospital	5,000.00
Meeker Recreation District	5,000.00
Clagget Memorial Hospital	5,000.00
St. Mary's Hospital-Proj. Critical Care	5,000.00
Miscellaneous	9,119.00
TOTAL	$62,293.00

9.0 ENVIRONMENTAL MONITORING

9.1 Scope

The Environmental Baseline Period for Oil Shale Tract C-b covered the period from November 1, 1974 to October 31, 1976. Results have been reported in nine Quarterly Data Reports, eight Quarterly Summary Reports, C-b Annual Summary and Trends Report (1976), and a 5-volume Environmental Baseline Program Final Report (1977), all submitted to the Manager of the Oil Shale Project Office. See References section (10.0) for more specifics.

From November 1, 1976 through August 31, 1977, the C-b Tract was under a period of suspension of the Federal Oil Shale Lease. The monitoring conducted during this period was executed under a program known as the Interim Monitoring Phase. Environmental data for this time period were submitted to the Oil Shale Project Office (OSPO) on October 14, 1977 (Interim Monitoring Report #1). The Interim Monitoring Period was later extended by the OSPO to cover the period from September 1, 1977 through March 31, 1978. Data for this time period were submitted to the OSPO on May 15, 1978 (Interim Monitoring Report #2). The Development Monitoring Program was initiated in April, 1978. The Development Monitoring Program for Oil Shale Tract C-b was submitted to the OSPO in a document dated February 23, 1979 and approved by the OSPO on April 13, 1979 subject to thirteen Conditions of Approval contained in the approval letter. Development Monitoring again reverted to Interim Monitoring status in March, 1982 as approved by the OSPO and has continued at that level to date. Actually an Interim Development Program and Schedule were approved on July 22, 1982 as Detailed Development Plan amendments. Interim monitoring has recently been extended into 1985 by the OSPO. Semi-annual environmental data reports are submitted every January 31 and July 31. Specific documents are cited in Section 10.

The Interim Monitoring and Development Montoring Programs have been reduced and changed from the Environmental Baseline Monitoring Program in many areas. Therefore, emphasis is now placed on key indicators of environmental quality and/or change.

In the summer of 1984 unauthorized woodcutting activities by a commercial cutter occurred in the Bailey Ridge area of the Tract. The site affected by the woodcutting activity was the control site for the pinyon-juniper woodland vegetation community, known as (Open) Plot 6 (or computer code BJ16) at location T3S, R96W, Section 9 (SE1/4,SW1/4,SW1/4). Therefore a program to initiate supplemental baseline monitoring in this affected area was submitted

to the OSPO on November 5, 1984 and approved by that office on November 19, 1984. This program is to be initiated in the summer of 1985 and includes phyto-sociological studies (community structure and composition), vegetation productivity studies, re-establishment of the deer and avifauna transects, and installation of a microclimate station. Results will be presented in future reports.

9.2 Purpose

The purpose of the Annual Report is to fulfill the requirement of the Lease to provide the OSPO with an annual summary of environmental monitoring. The Development Monitoring Plan states the following objectives with respect to environmental monitoring:

> The purposes or objectives of environmental monitoring as defined in Section 1 (C) of the Lease Stipulations are to provide: (1) a record of changes from conditions existing prior to development operations, as established by the collection of baseline data, (2) a continuing check on compliance with the provisions of the Lease and Stipulations, and all applicable federal, state and local environmental protection and pollution control requirements, (3) timely notice of detrimental effects and conditions requiring correction, and (4) factual basis for revision or amendment of the Stipulations.

9.3 Summary of Environmental Monitoring

Environmental monitoring is continuing on Tract C-b. Development activities commenced within the past seven years have resulted in activity on the Tract in the form of off-road vehicular use, facility construction, shaft sinking and outfitting associated headframes, and traffic into and out of the area. All activities have been conducted within strict adherence to environmental, permit, and Lease regulations.

9.3.1 Indicator Variables

The environmental monitoring program has been brought into sharper focus with the identification of Class I indicator variables. These are key environmental variables collected at representative stations in at least monthly sampling frequency. Time series plots, generated by the computer from the data base for many of these variables, appear in the 6-month Data Reports submitted to the OSPO.

[illegible]

[illegible]

[illegible]

> [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

9.3.2 Tract Imagery

Tract imagery, in forms of color infrared panoramic photographs of vegetation around springs and seeps and use of Landsat for assessment of general vegetative conditon, has been discontinued since 1982 in view of decreased Tract activity, with OSPO approval.

9.3.3 Hydrology and Water Quality

The environmental monitoring program provides hydrologic and water quality data for the purpose of evaluation of potential impacts. Streams, springs, seeps, alluvial and bedrock aquifers, shafts and impoundments are presently monitored. The monitoring station locations and sampling frequencies are shown in the 6-month data reports for these programs.

The simplified two-layer aquifer concept that guided the measurements of flows and levels during the early monitoring program has evolved through study and analysis to the more detailed system in Figure 9-1. The revised concept identifies six general stratigraphic zones: Upper or Unconfined Uinta (UUN), Lower or Confined (LUN), Upper Parachute Creek 1 (UPC_1), Upper Parachute Creek 2 (UPC_2), Lower Parachute Creek 3 (LPC_3), and Lower Parachute Creek 4 (LPC_4). The LPC_3 interval includes the zone to be mined and dewatered. Shown on the figure is a possible depth of both a room and pillar mine and a Modified-In-Situ retort, although neither exists on Tract at present. Also shown on the figure are the five layers defined by Taylor of the USGS and utilized in the CB groundwater model; these layers are utilized on the drawdown curves presented later.

Two items potentially affect the hydrologic monitoring program and its results: cessation of dewatering of the V/E shaft and water management practices. Each are discussed in turn.

The V/E shaft was allowed to fill in accord with approved plans in September 1981, as a temporary cost-saving device (i.e. reduction in cost of pumping for dewatering). Water level in this shaft reached the equilibrium level of approximately 6310 feet in the spring of 1982.

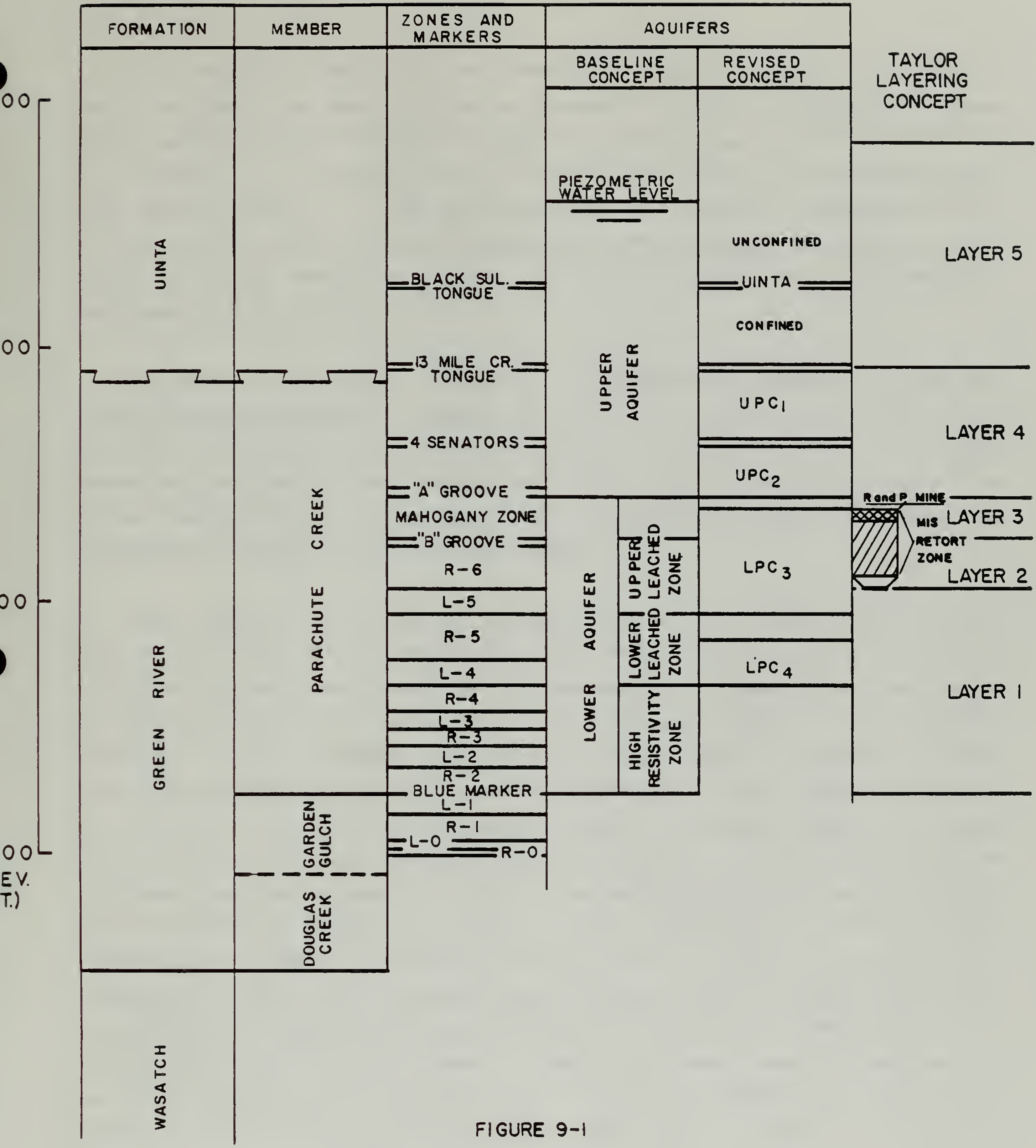


FIGURE 9-1

Stratigraphic Column and Aquifer Concept, Also Showing CB Room & Pillar and MIS Mine Zone and Taylor's Layering Concept

Over the past several years management of the excess waters due to dewatering of the shafts has been the major environmental activity. Historically, these excess waters have been disposed by temporary pond storage in Ponds A/B followed by discharge to 1) Piceance Creek via East No Name Gulch, 2) reinjection into deep aquifers and/or, 3) land application via sprinkling. Although the only facility used in 1983 and 1984 incorporated surface storage and discharge, the other facilities which were used earlier also have some time-residual environmental/hydrologic effects.

In addition to routine monitoring, the hydrological program in 1984 addressed monitoring potential seepage from the holding ponds, monitoring stream flows and well levels to determine any potential effects resulting from shaft dewatering, monitoring the discharge under NPDES permit, and monitoring of the changed concentrations of fluoride in Spring S102(WS12)* along with formulating alternative hypotheses to explain such changes.

With regard to monitoring of streamflow, that for Piceance Creek up- and downstream of the Tract is summarized on Table 9-1. Baseline studies for 1975-76 indicated that the annual mean flow for the reach of Piceance Creek immediately downstream of the Tract (Station 6061 (WU61)) is approximately 17 CFS. Records since then indicate no major variations in annual mean flow except for water years 1983 and 1984 (wet years) for which the mean flow at the downstream station was 60 CFS and 72.5 CFS respectively. During irrigation seasons - one-day minimum flows in Piceance Creek have reached zero flow in previous years. In the 1984 water year the minimum daily flow at the downstream station was 22 CFS; the maximum was 426. Figures 9-2a and -2b show histograms of monthly average streamflows for 1980 (a relatively dry year) and for 1984 (a wet year) for Stations 9007, 9061, 6200 (Piceance Creek below Ryan Gulch) and 4800 (White River below Meeker). Monthly total precipitation at Little Hills (WR01) and at C-b Station 023 (AB23) are also shown. Table 9-2 shows annual streamflows at near-Tract tributaries to Piceance Creek: Stewart Gulch (9022) and Willow Creek (9058). The underlying conclusion from these data is that C-b has had no discernible effects on surface flows.

* In this section the "popular" station designation is given first followed by the computer code in parenthesis. Table 3.2-1 of the January 1985 Data Report cross references both designations.

TABLE 9-1

Piceance Creek Streamflows

		Flow (cfs) for Water Year						
Station		1978	1979	1980	1981	1982	1983	1984
6007 (WU07)	Max. Daily	83.0	158.0	135.0	18.0	29.0	365.0	410.0
	Annual Mean	9.7	20.8	20.0	7.2	8.0	47.0	55.8
	Min. Daily	0.6	2.0	5.1	0.5	1.3	5.2	10.0
6061 (WU61)	Max. Daily	52.0	149.0	133.0	34.0	37.0	430.0	426.0
	Annual Mean	10.9	24.6	25.6	12.9	11.4	60.0	72.5
	Min. Daily	0.0	0.6	4.6	0.5	2.9	8.9	22.0

6007 = Piceance Creek Below Rio Blanco

6061 = Piceance Creek Above Hunter Creek

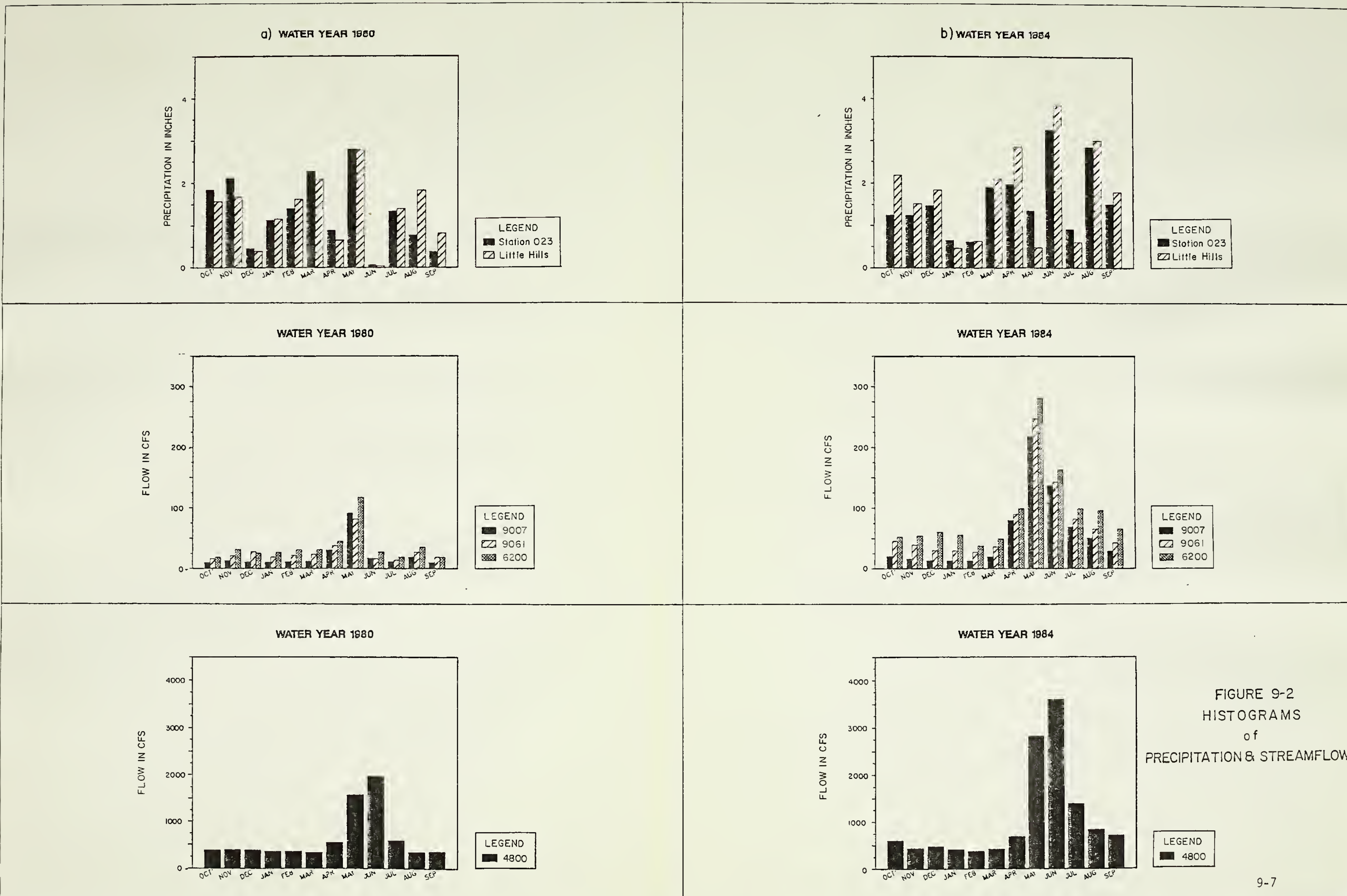


FIGURE 9-2
HISTOGRAMS
of
PRECIPITATION & STREAMFLOW

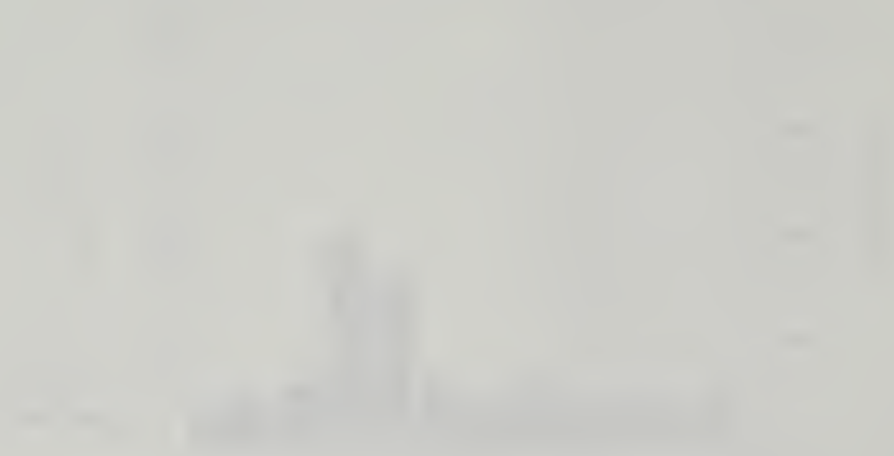


TABLE 9-2

Annual Streamflows at Near - Tract Tributaries to Piceance Creek

(ac-ft)

Water Year	Willow Creek (9058)	Stewart Gulch (9022)
1975	1437	1407
1976	1715	1933
1977	1008	999
1978	737	868
1979	820	898
1980	2891	1348
1981	1665	1203
1982	1043	1000
1983	2927	1739
1984	4666	2666

In 1981 and 1983 the USGS conducted gain-loss studies along Piceance Creek along 50 stream miles. Results are shown on Figure 9-3 for these dry and wet years, respectively.

The Water Augmentation Plan requires that correlations be attempted between precipitation and streamflows, the suggested correlation being precipitation at the Little Hills Station with streamflow in Piceance Creek below Ryan Gulch (Station 6200). The results of this attempted correlation for Water Year 1984 are shown on Table 9-3 utilizing the data shown on Figure 9-2b. There was no correlation. Baseflow was then subtracted out; again there was no correlation. For Water Year 1984: 1) precipitation at C-b Station 023 correlated well with that at Little Hills; and 2) streamflow at Piceance Creek upstream of the Tract (Station 9007) correlated well with that below Ryan Gulch (Station 6200). The correlation of streamflow below Ryan Gulch in Water Year 1980 correlated with that for Water Year 1984 at the same station (from data of Figure 9-2) with a Coefficient of Determination (r^2) of 0.56.

With regard to groundwater, data collected over the past five years continue to strongly suggest that the tight confining zones of oil shale restrict the vertical movement of groundwater between the major hydrologic units.

Time histories of water levels for 10 selected bedrock wells are presented in Figure 9-4. Wells completed in the reinjection zones (UPC_2 and LPC_3) showed responses to reinjection but the zones above show no effects. Wells near the ponds (41X-13 near Pond C and SG-10A-U1) only show effects of seepage and no responses to reinjection.

Head-level changes in the wells are depicted on contour plots of Figures 9-5 and 9-6. Figures 9-5a and -5b show changes for Layer 2 (refer to Figure 9-1) for January 1982 and January 1984 respectively. Layer 2 wells show both effects of dewatering and reinjection. To the southeast of the shaft area around the reinjection well, head increases can be seen in January 1982. Figure 9-3 shows these wells and the reinjection periods. Lower heads due to dewatering can be seen to the northwest. Figure 9-5b shows only effects of dewatering since reinjection stopped in 1982. Figures 9-6a and -6b show changes for Layers 4-5 for January 1982 and January 1984 respectively. Again as is seen with Layer 2,

Figure 9-3
GAIN/LOSS STUDIES ALONG PICEANCE CREEK
(RAW DATA)

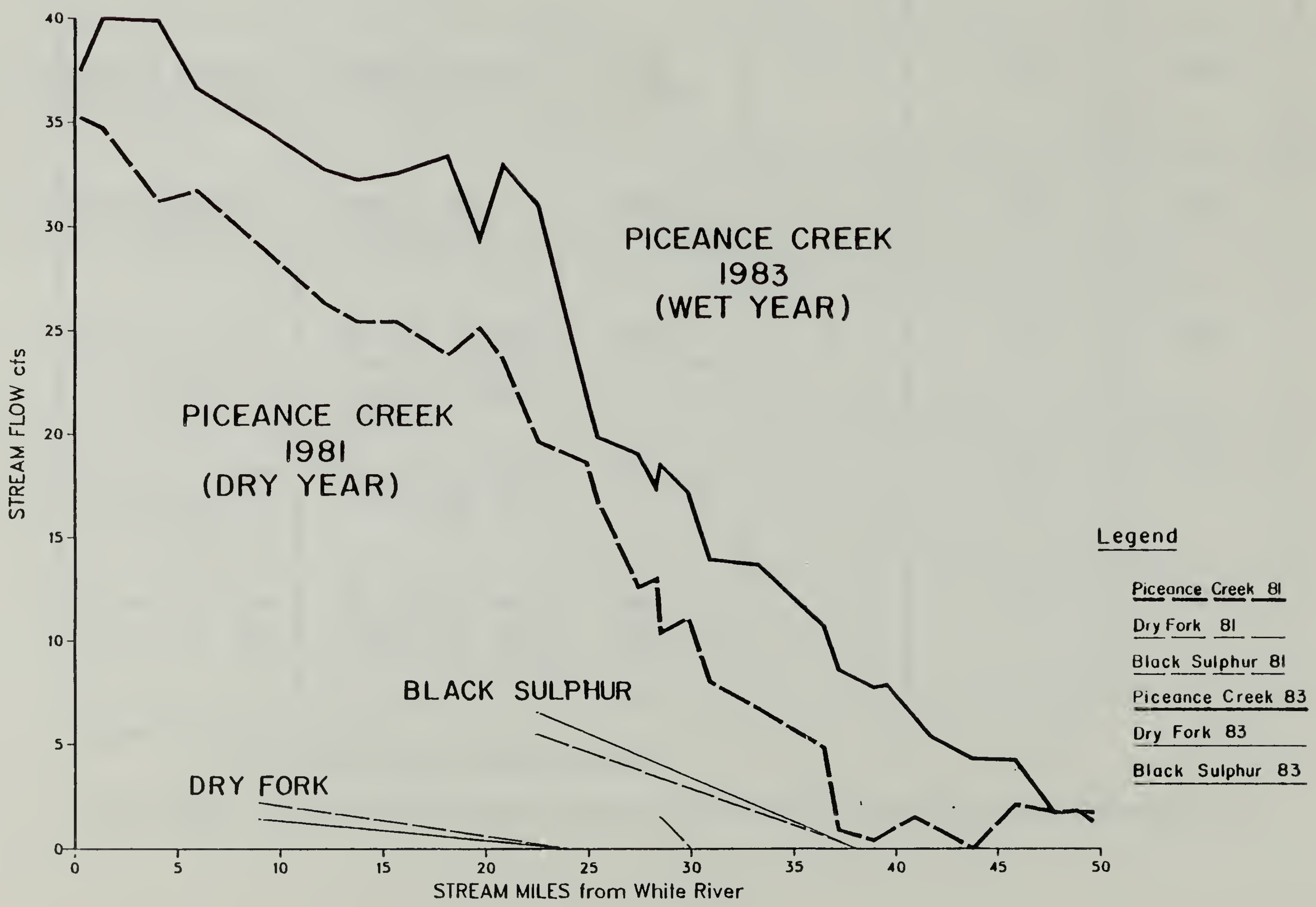


TABLE 9-3

Precipitation and Streamflow Regressions

Variable x	Variable y	Data Set	No. of Sample Pairs	Regression Constants		
				a	b	r^2
Monthly Precip. @ C-b Sta. 023 (in.)	Monthly Precip. @ Little Hills (in.)	Water Yr. 1984	12	-0.17	1.23	0.82
Monthly Precip. @ C-b Sta. 023 (in.)	Monthly Precip. @ Little Hills (in.)	1977 - 1984	79	0.12	0.95	0.65
Monthly Precip. @ Little Hills (in.)	Monthly Avg. Streamflow @ Sta. 6200 (cfs)	Water Yr. 1984	12	NG	NG	0
Monthly Precip. @ Little Hills (in.)	Mo. Avg. Streamflow @ Sta. 6200 (cfs)Less Baseflow	Water Yr. 1984	12	NG	NG	0
Mo. Avg. Streamflow @ Sta. 9007 (cfs)	Mo. Avg. Streamflow @ Sta. 6200 (cfs)	Water Yr. 1984	12	32.9	1.07	0.97
Mo. Avg. Streamflow @ Sta. 6200 (cfs) - Yr. 1980	Mo. Avg. Streamflow @ Sta. 6200 (cfs) - Yr. 1984	Water Yrs. 1980, 1984	12	30.8	1.83	0.56

Regression: $y = a + bx$
r^2 = Coefficient of Determination

Station 6200 = Piceance Creek @ Ryan Gulch; Station 9007 = Piceance Creek @ Stewart Gulch

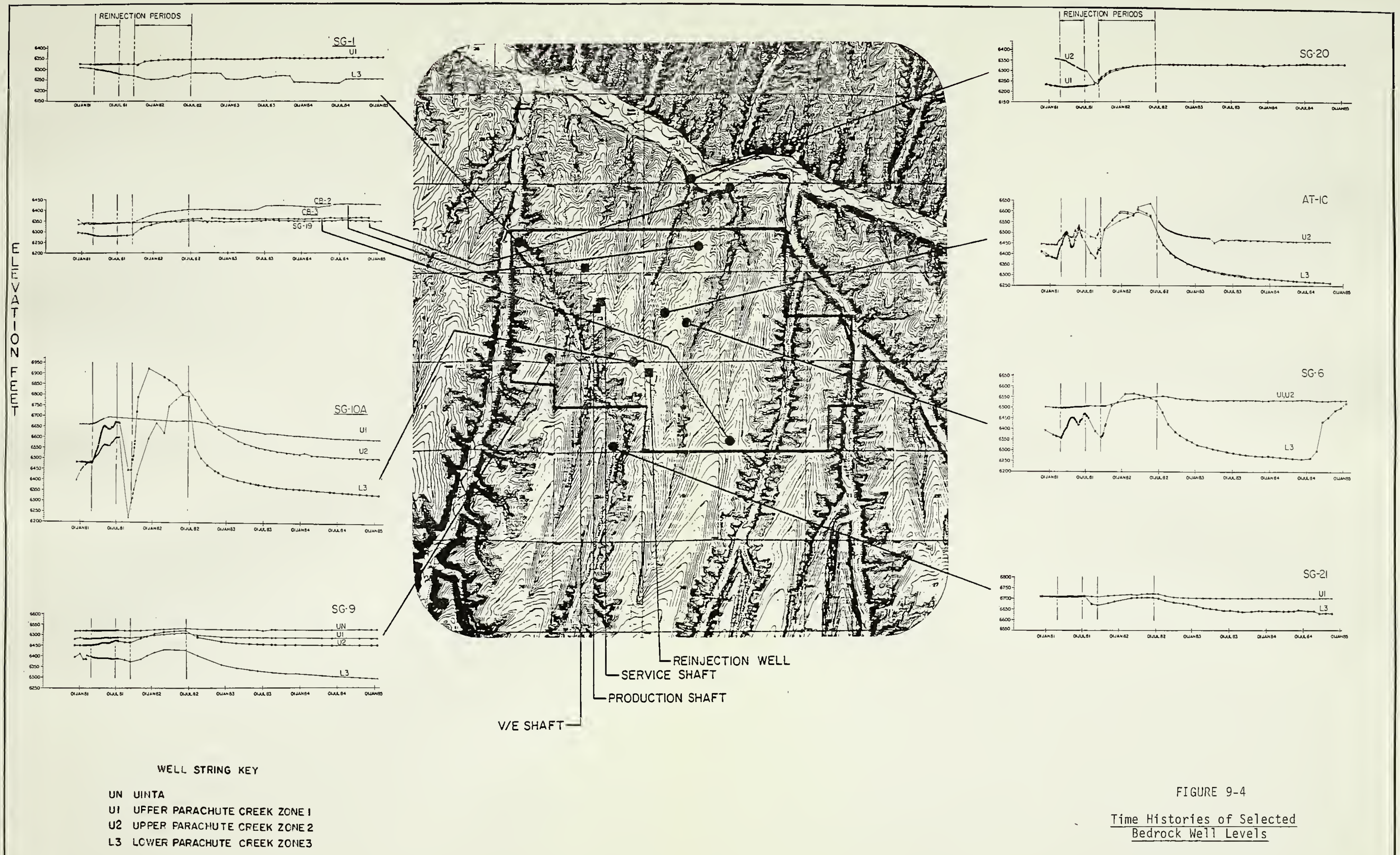


FIGURE 9-4

Time Histories of Selected Bedrock Well Levels

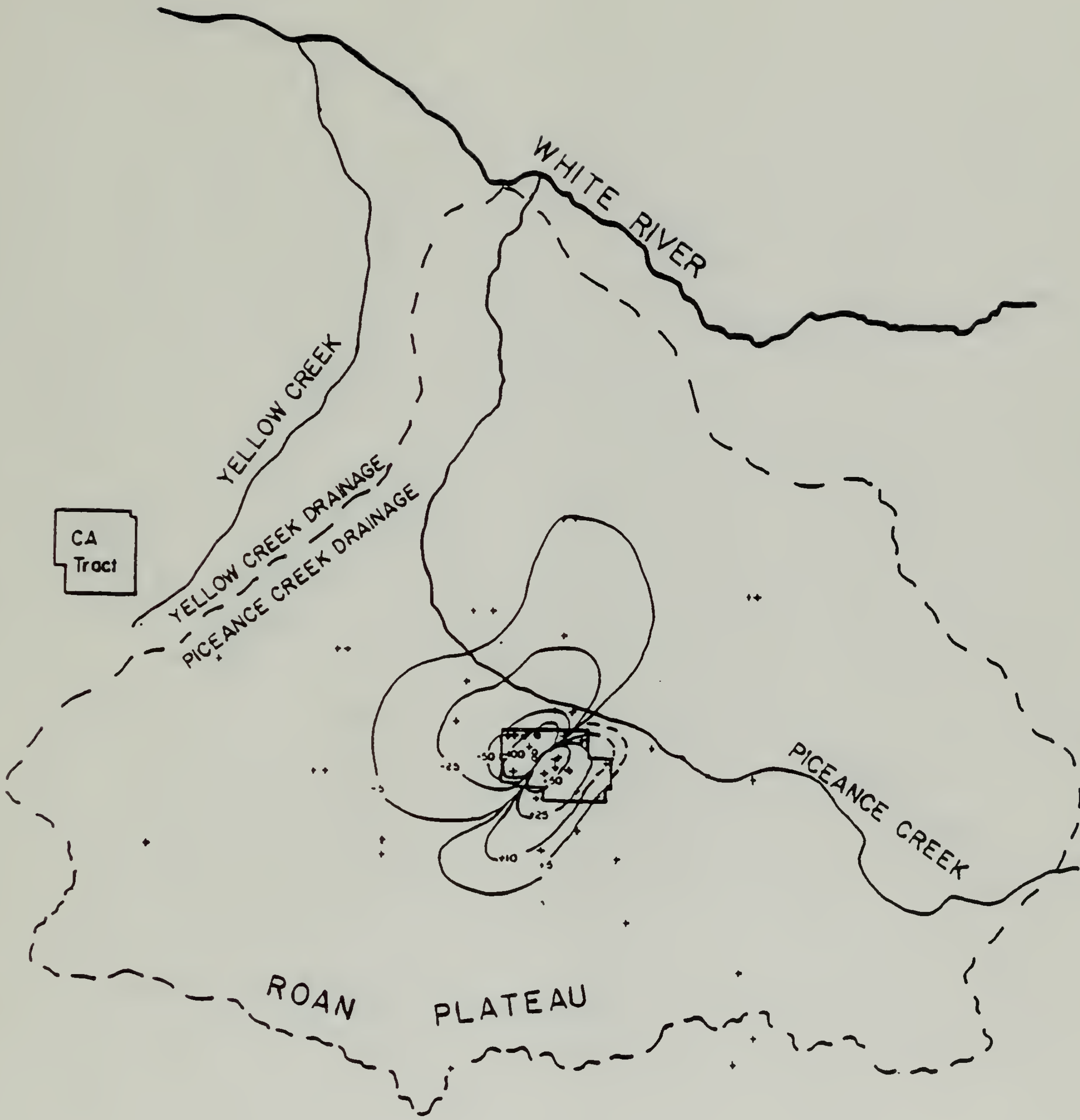


FIGURE 9-5 Changes in Bedrock Layer 2 Head Levels (Ft) from Baseline
a) January 1982

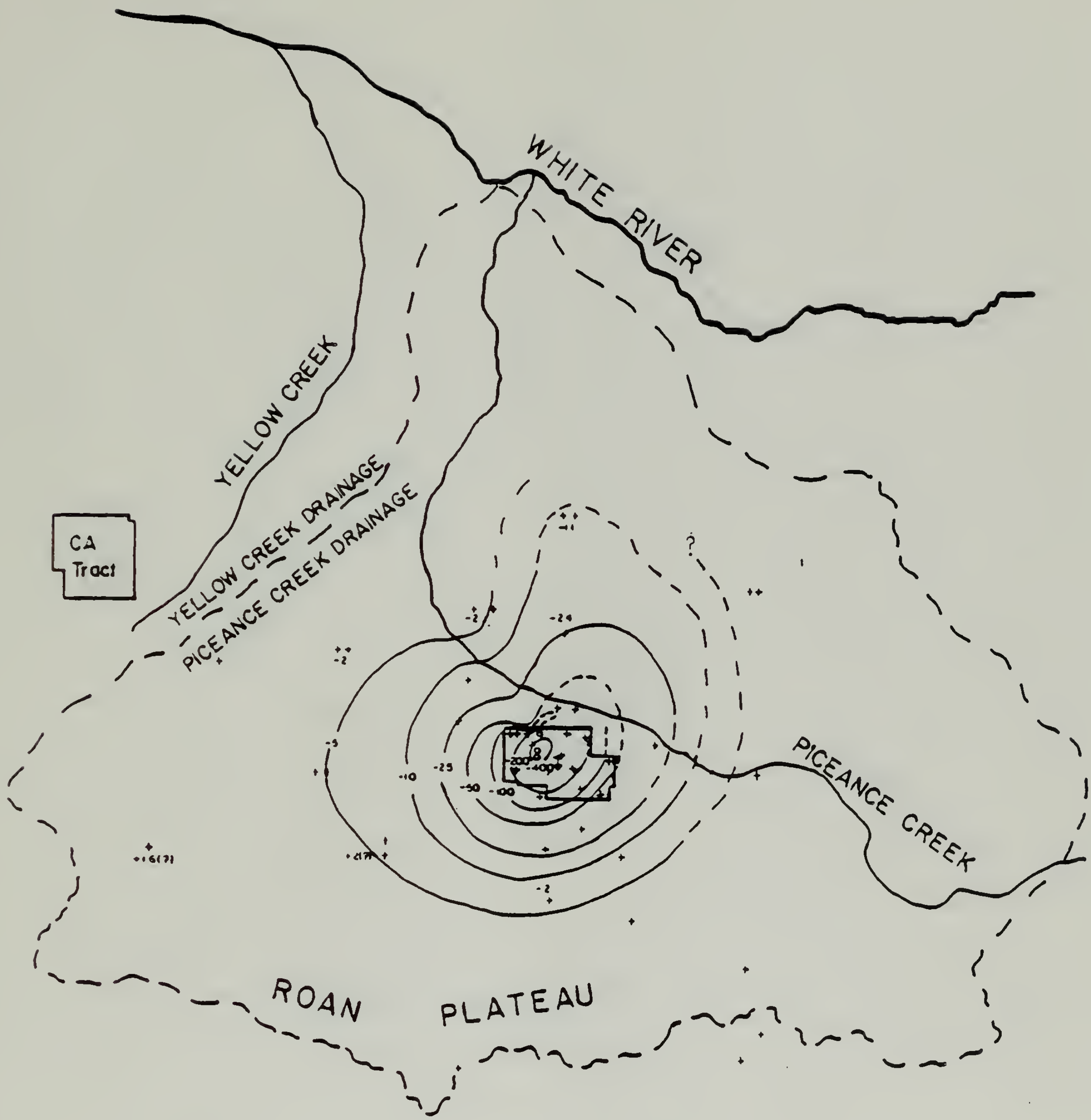


FIGURE 9-5 Changes in Bedrock Layer 2 Head Levels (Ft) from Baseline
b) January 1984

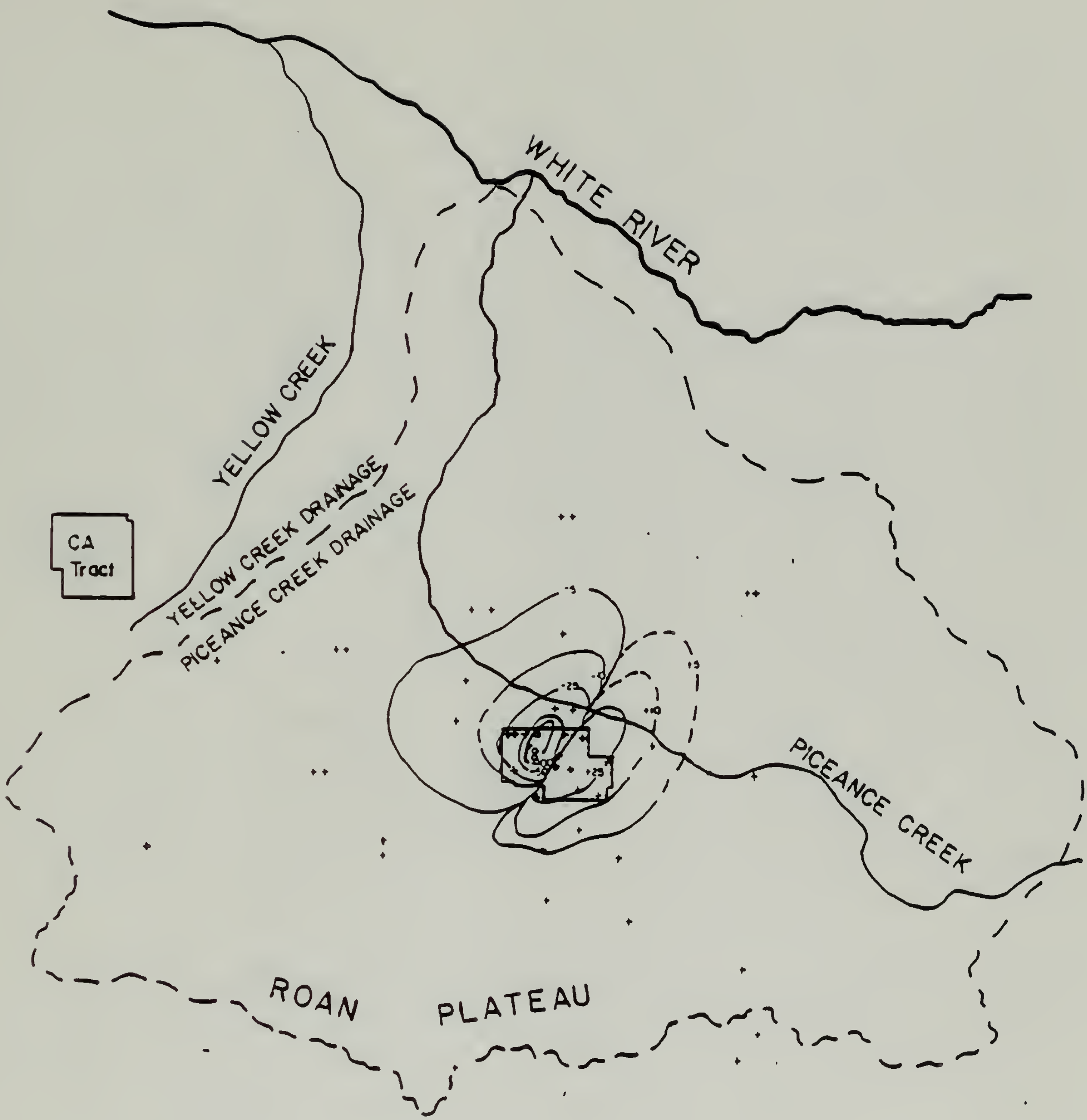


FIGURE 9-6 Changes in Bedrock Layer 4-5 Head Levels (Ft) from Baseline

a) January 1982

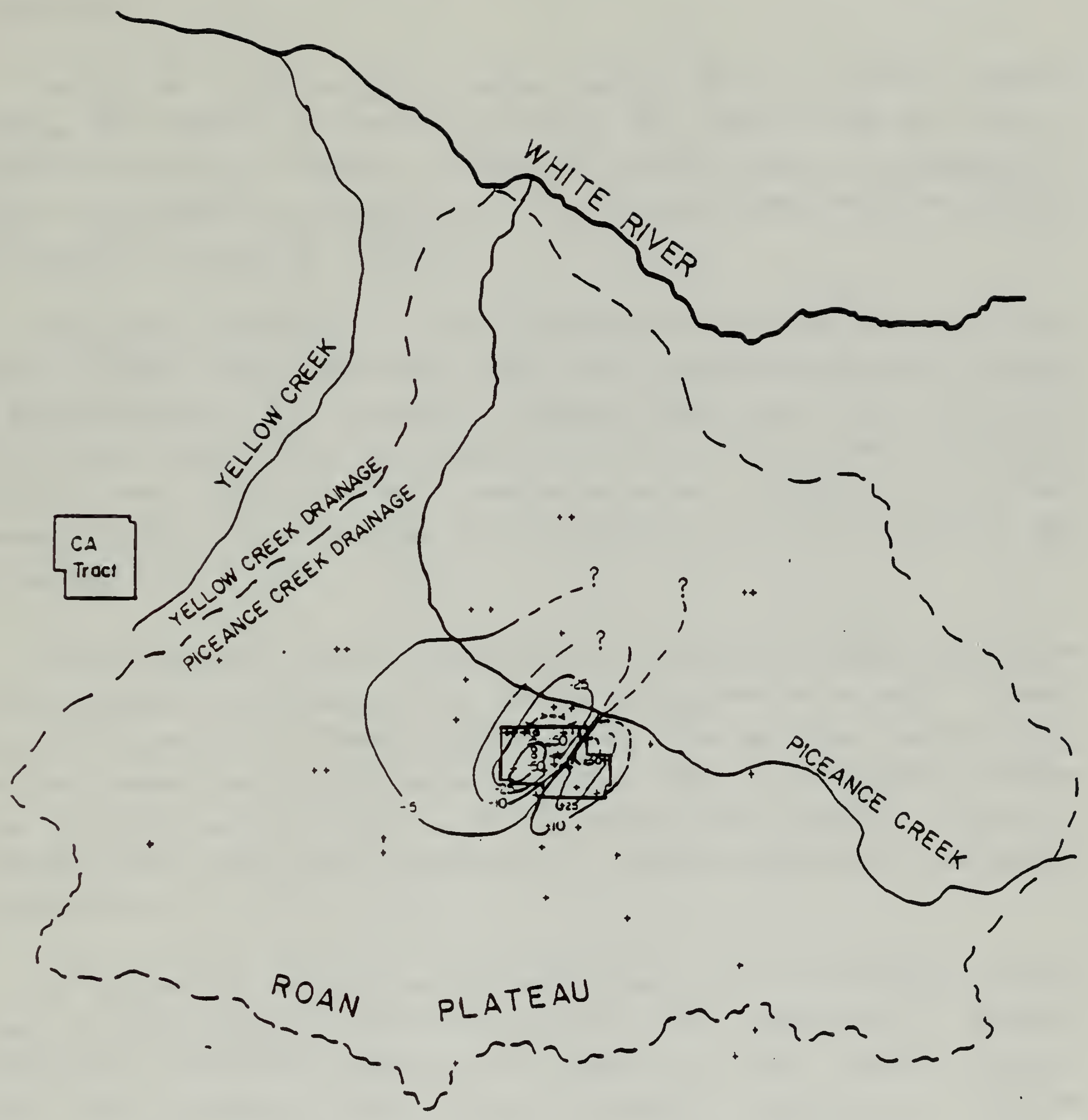


FIGURE 9-6 Changes in Bedrock Layer 4-5 Head Levels (Ft) from Baseline
b) January 1984

heads show positive increases to the southeast and negative in the northwest. However in January 1984, Layer 4-5 is still showing remnant effects of reinjection.

Turning now to the subject of water quality, data for stations upstream (Station 9007 (WU07)) and downstream (Station 9061 (WU61)) from the Tract on Piceance Creek and for stations in Stewart and Scandard Gulches are summarized on Table 9-4 by comparison with baseline. Ratios of twelve-month means for Stations 9061 and 9007 are shown on Table 9-5.

During 1984, discharges to East No Name Gulch were made during the year under the NPDES permit, and Station 9042 (WU42) measured water quality affected by these discharges. All discharges in 1984 contained fluoride levels characteristic of the lower aquifer zones ranging from 19 to 24 mg/l; when diluted with Piceance Creek waters the fluoride maximum value was 1.0 mg/l. On an annual average, fluoride which increased (@ Station 9061) from 0.8 to 2.2 mg/l in 1981 is now back to 0.7.

The holding pond (Pond A/B) was checked for seepage by comparing key water quality parameters with those of its downdip seepage monitoring well. Current mine water pumped to the ponds comes primarily from the lower aquifer (LPC_3) and has elevated levels of sodium and fluoride. Water in the seepage monitored from the upper aquifer (UPC_1) is of high calcium, low fluoride. Table 9-6 shows that these upper aquifer characteristics have been preserved in the seepage monitoring well.

For springs and alluvial and deep wells there are no significant long-term trends in water quality values for any of the major constituents. Variables examined for trends were temperature, pH, conductivity, DOC, arsenic, fluoride, boron, TDS, molybdenum, sodium, sulfate, and ammonia. Spring S102 is the one exception. Its fluoride level has increased to levels of 7-8.6 mg/l in 1983-84 from values typical of all other springs (0.5-1) in 1980 as shown in Figure 9-7. This spring is downstream of the East No Name Gulch discharge point. The analysis undertaken (Ward, 1984) has postulated the following hypotheses for possible sources of recharge for this spring:

TABLE 9-4

Comparisons of 1984 Water Year vs. Baseline for Mean Values of Major Water Quality Constituents (mg/l)

	WU07 (P.C. Upstream of Tract)		WU22 (Stewart Gulch)		WU58 (Willow Creek)		WU61 (P.C. Downstream of Tract)	
	1983-1984	Baseline	1983-1984	Baseline	1983-1984	Baseline	1983-1984	Baseline
NH_3	0.06	0.04	0.04	0.02	0.05	0.02	0.03	0.03
As	0.0022	0.0024	0.0008	0.0010	<0.001	0.0011	0.0014	0.0023
B	0.138	0.209	0.080	0.108	0.123	0.210	0.138	0.214
Ca	74	69	87	93	89	92	75	78
Cl	15.5	15	7.6	7.2	12.5	11.5	14.8	14
F	0.7	0.9	0.3	0.3	0.4	0.4	0.7	0.9
Mg	44	46	71	76	64	76	52	67
Mn	0.022	0.046	0.009	0.010	0.020	0.014	0.016	0.066
K	2.7	3.6	1.3	1.6	1.9	2.2	2.6	3.5
Si	14	15	15	15	17	15	15	17
Na	97	122	124	124	108	128	110	150
TDS	643	692	890	936	798	926	726	902
SO_4	208	164	352	368	297	356	246	290

Station values in 1983-1984 are for the months of 10/83 thru 9/84 (i.e. WY 1984) from USGS water data.

Baseline values are for the period 11/74 to 10/76 - from environmental baseline program.

TABLE 9-5

Downstream-to-Upstream* Ratios
of 12-Month Mean Values of Water Quality Parameters
October 1 - October 1**

	Baseline	1980-1981	1981-1982	1982-1983	1983-1984
Alk	1.1	1.2	1.1	-	-
NH_3	0.8	1.4	1.0	1.1	0.5
As	1.0	1.0	1.1	0.9	0.6
B	1.0	1.1	1.0	0.9	1.0
Ca	1.1	1.0	1.1	1.0	1.0
Cl	0.9	0.7	1.0	0.9	1.0
F	1.0	2.2	1.4	1.2	1.0
Mg	1.5	1.3	1.4	1.2	1.2
Mn	1.4	0.5	0.8	0.9	0.7
K	1.0	1.1	1.0	1.0	1.0
Si	1.1	1.2	1.1	1.1	1.1
Na	1.2	1.4	1.2	1.1	1.1
SO_4	1.8	1.6	1.3	1.2	1.2
TDS	1.3	1.3	1.7	1.2	1.1

*Station 9061 (WU61) is on Piceance Creek, downstream of the Tract;
Station 9007 (WU07) is on Piceance Creek, upstream of the Tract.

**No NPDES discharge occurred from October 1981 thru June 1982.

The tabular values are the ratio of $\frac{\text{WU61}}{\text{WU07}}$

[illegible]

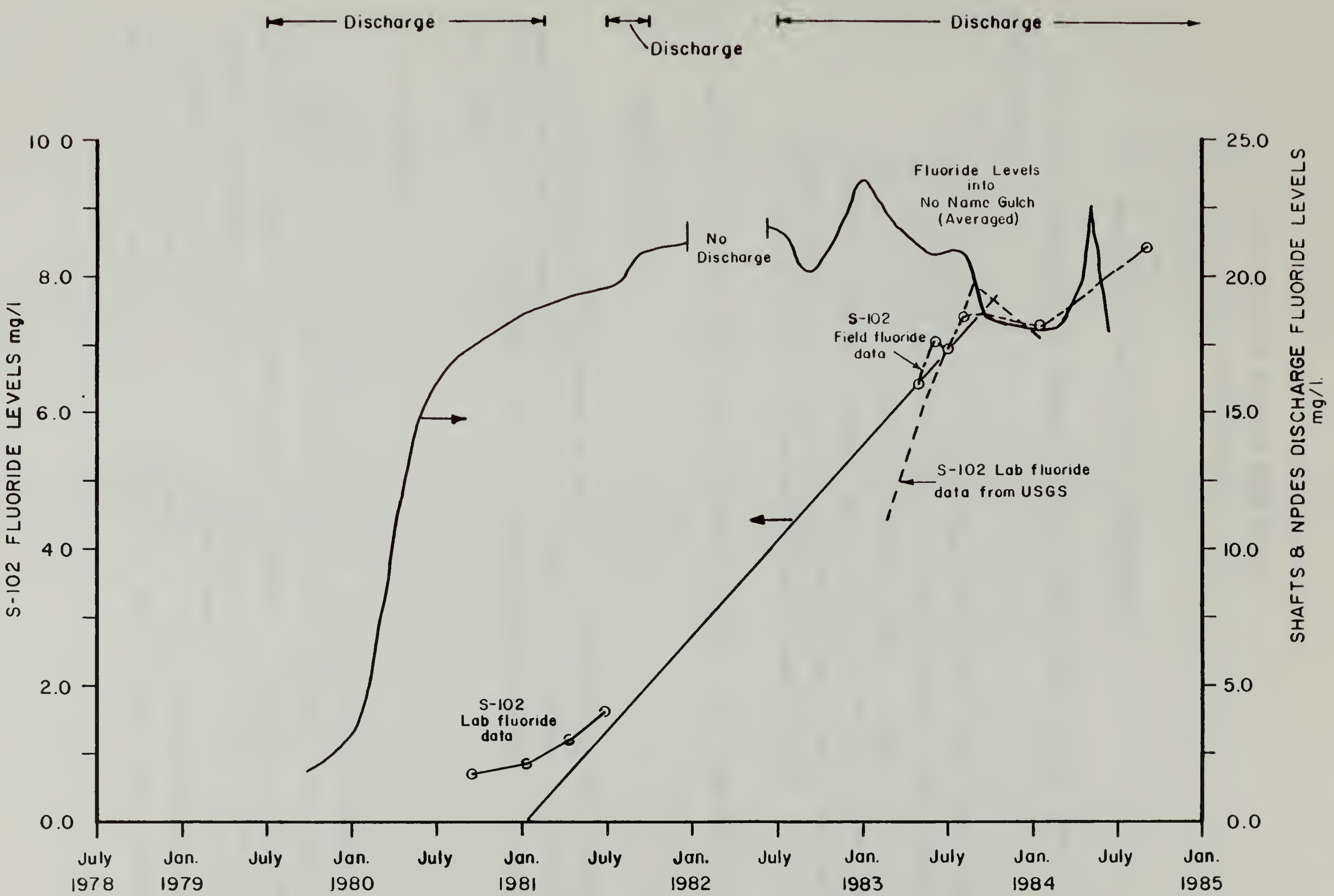
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

TABLE 9-6

Comparison of Water Quality in Pond A/B (WN40) with its Seepage Monitoring Well (WW22)

Water Quality Parameter	Sampling Date	Value (mg/l) Pond	Seepage Well
Na	Spring '81	-	170
	Spring '82	540	250
	Spring '83	610	260
	Spring '84	-	280
F	Spring '81	19	1.5
	Spring '82	22	0.7
	Spring '83	21	0.3
	Spring '84	23	0.4
Ca	Spring '81	-	98
	Spring '82	5.2	150
	Spring '83	7.1	230
	Spring '84	5.0	200



FLUORIDE CONCENTRATION TIME HISTORIES for the NPDES DISCHARGE INTO EAST NO NAME GULCH and for SPRING S-102

FIGURE 9-7

1. NPDES flow into East No Name Gulch
2. Infiltration from Ponds A/B
3. Pond C
4. V/E Shaft
5. Upwelling of deep aquifer groundwater.

The first hypothesis is favored at this time, which may be more fully described as:

> NPDES discharge into East No Name Gulch enters the Upper Uinta aquifer through open joints and fractures within the Uinta Formation exposed along the underlying alluvium within No Name Gulch. The effluent migrates northwest and mixes with fresher Upper Uinta groundwater as it crosses the weathered Black Sulphur Creek tongue and discharges at S-102 and into Piceance Creek alluvium.

Analysis is continuing to further reinforce or refute this hypothesis.

9.3.4 Aquatic Biology

The purpose here is to summarize benthic macroinvertebrate and periphyton communities along Piceance Creek around C-b Tract and to evaluate the effects of C-b's activities on the aquatic system. Detailed analyses appear in the 6-month data reports.

9.3.4.1 Benthos

The trends in density changes (Figure 9-8) and in relative abundance over the 1980-84 period have been similar at all three stations even though the magnitude of changes has varied among the stations. Therefore, influences on Piceance Creek other than Tract C-b discharge (e.g., natural flow rates, irrigation) probably have as much or greater impact on the macroinvertebrate density. Any impact of Tract C-b discharge on the macroinvertebrate density would likely be obscured by the effect of the other factors (e.g., flooding, irrigation) on the creek.

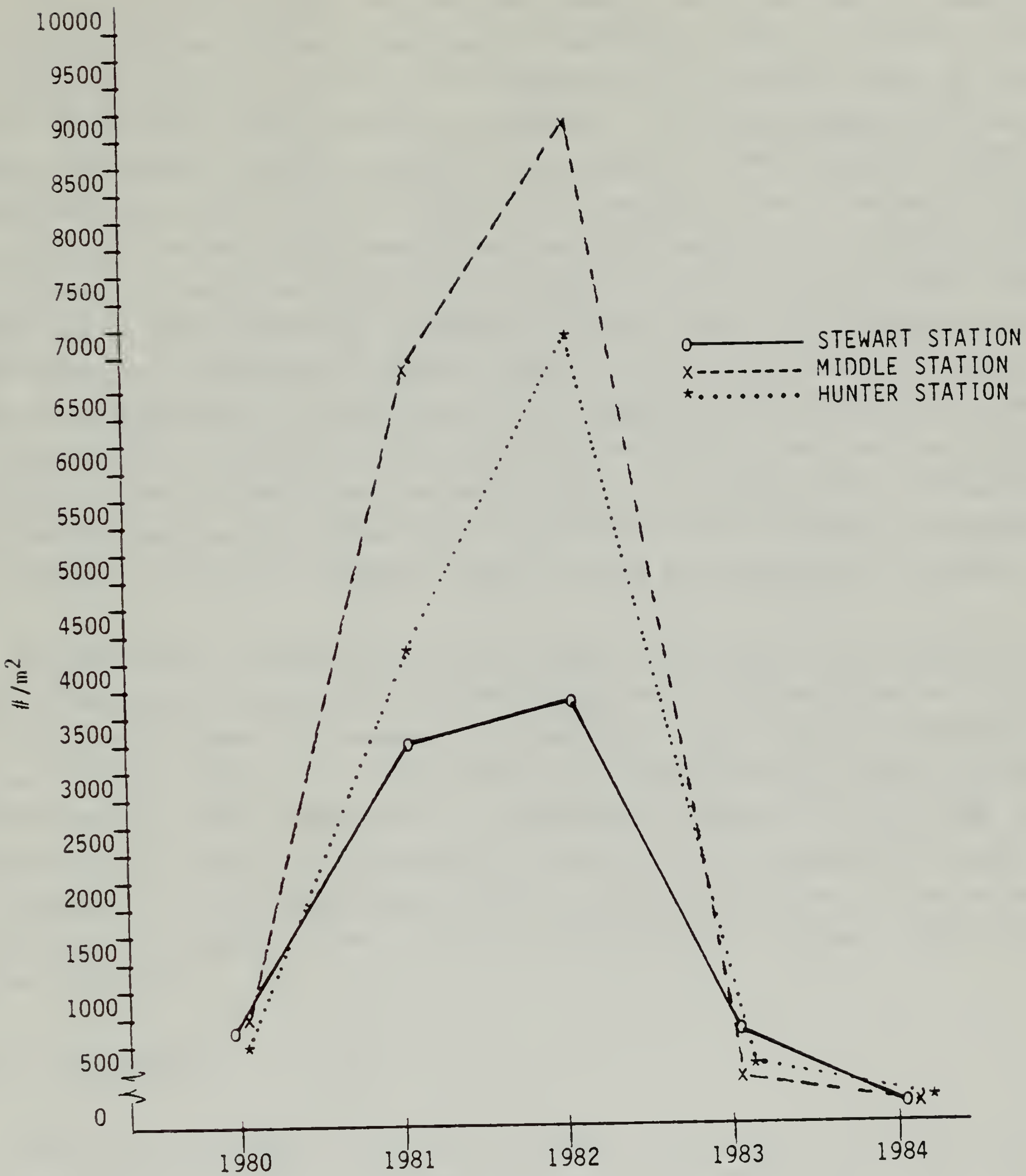


FIGURE 9-8

Mean of Monthly Densities ($\#/m^2$) of Benthic Macroinvertibrates at Stewart, Middle, and Hunter Stations during May through October, 1980-1984

1 Gray and Ward (1978) reported that benthic macroinvertebrate density, diversity, and biomass tended to decrease in downstream reaches of Piceance Creek which they attributed, in part, to the withdrawal of irrigation water and the inflow of groundwater and spring-fed tributaries. This same pattern of lower values at downstream locations generally was evident in 1984; moreover, density values were lower at all sites in 1984 than in previous years. Unusually high flows occurred for the second consecutive year (see Section 9.3.3 Hydrology and Water Quality). Macroinvertebrate benthic sampling could not begin in May 1983 or 1984 due to flood conditions. Streamflows in May, June, and July 1984 were 16 to 25 times 1982 streamflows at Stewart Station and 14 to 39 times 1982 streamflows at Hunter Station. Streamflows in later months in 1984 were 2 to 5 times the flows in 1982. These high flows have continued to scour the gravel substrate of Piceance Creek through the monitoring area. The same groups of macroinvertebrate (Haplotaxida, Epehmeroptera, and Diptera) still tended to predominate; however, the relative abundance among the taxa has changed over the years.

The same general seasonal and annual trends in the density and composition of macroinvertebrate communities have been exhibited in stations above and below the Tract C-b discharge. It appears that some factor other than the development of the C-b Tract accounted for the differences observed among stations during 1984 and previous years. Specifically, streamflow was unusually high in 1984 and 1983, resulting in lower densities due to scouring of the streambed and associated changes in macroinvertebrate habitat. Density reductions of the degree observed at all three stations also have been reported in other studies for similar situations.

9.3.4.2 Periphyton

Since similar changes in periphyton density have occured at stations both above and below the Tract C-b discharge (Figure 9-9), factors other than Tract C-b appear to have a greater influence on periphyton than Tract C-b discharge; these other factors also would obscure any effect of the Tract C-b discharge. As would be expected, seasonal trends in biomass data are similar to those exhibited by the density data.

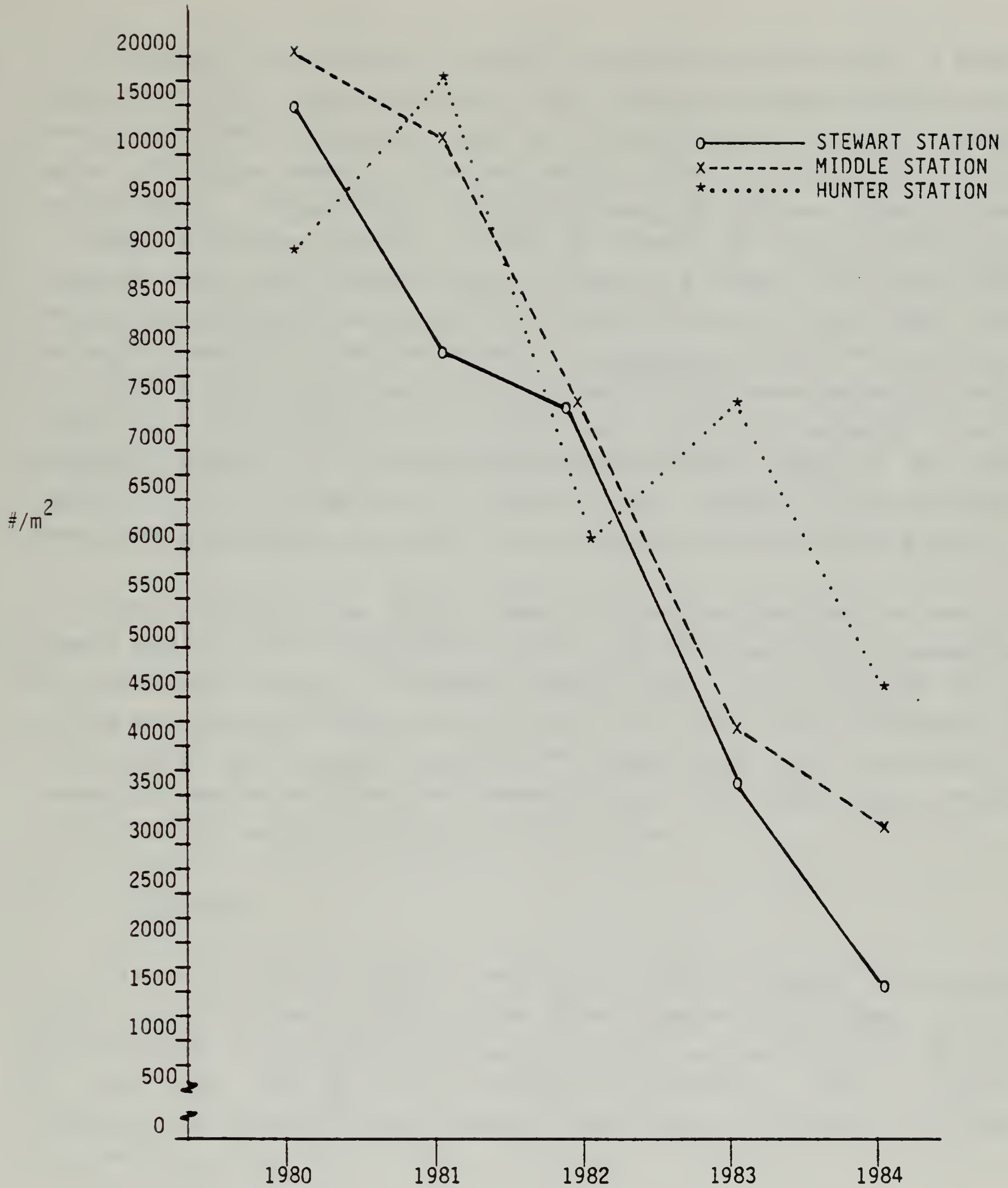


FIGURE 9-9

Mean of Monthly Densities of Periphyton (units/mm^2) at Stewart, Middle, and Hunter Stations During May through October, 1980-1984

High water flows continued to impact the study area during 1984 in a manner similar to the high flows experienced in 1983. Macroinvertebrate density values were lower in 1984 than previous years for all three stations during the 1980-84 period. Periphyton density in 1984 was generally lower at all stations than in previous years. Average monthly periphyton biomass in 1984 was slightly higher in 1983. Periphyton diversity in 1984 at Stewart and Hunter Stations was generally lower than in previous years; diversity at Middle Station was lower than for previous years as sampled late in 1984 but higher in early 1984. The periphyton community in 1984 was dominated by Achnanthes species, which are early colonizers on glass slides and are usually the first to appear after high water flows have scoured the substrate clean of any established periphyton growth. Periphyton species that typically dominate more mature communities were less abundant in 1983 and 1984 than in previous years. Changes in the periphyton communities have been similar at all three stations during the 1980-84 period.

Similar changes in the aquatic communities have occurred over the years at Stewart Station, which is the control station, and at Hunter Station, downstream of development activity. Variations observed over the years seem to be attributable to natural factors, not to Tract C-b. If the Tract C-b discharge is causing impact to the aquatic ecosystem of Piceance Creek, then this impact is apparently obscured by natural environmental factors that likely have a greater influence on the aquatic resources of Piceance Creek.

9.3.5 Air Quality

Trailer Station 023 (AB23) was the only air quality station active during 1984. It is co-located on Tract with the 60-meter meteorological tower. Station AB23 has been in continuous operation since 1974 and monitors NO_x, NO, NO_2, O_3, SO_2, H_2S, CO and total suspended particulates (TSP). Gaseous parameters are reported as hourly averages; particulates are sampled for 24 hours every fourth day.

Compliance with National Ambient Air Quality Standards was achieved in 1984 as indicated on Table 7-1. Data are shown for all years, including baseline. Ozone continues to be the only air quality parameter whose ambient levels reach a substantial fraction of the air quality standard. Since ozone is the product of

atmospheric reactions and is also present in the stratisphere, rather than an emitted substance, its concentration is subject to variation due to: 1) stratigraphic down-mixing, 2) changes in the intensity of insolation, providing the driving force for ozone-producing reactions, and 3) to long-range transport from industrial sources. This results in both a seasonal and diurnal pattern in the ozone levels, with the highest mean concentrations in summer (particularly in the heat of the day), and lowest in winter. Over the history of ozone monitoring on-Tract, this seasonal pattern coupled with the large random component has been consistently present.

Figure 9-10 is a histogram of ozone readings grouped by concentration class for 1984. Mean concentration was 71 ug/m^3; highest concentration was 135 ug/m^3. Less than 1% of the observations were greater than 110 ug/m^3.

Though recent particulate levels are well below ambient standards, high readings have been recorded particularly during baseline (see Table 7-1). High levels are attributed to fugitive dust. Particulate distributions are essentially independent of prevailing wind directions. High particulate concentrations are recorded during the summer months, when the wind is exhibiting its strongest influence of the year.

The histogram of particulate concentrations for 1984 (Figure 9-11) shows that 98% of the concentration readings are less than 35 ug/m^3; the geometric mean value for the year is 4.6 ug/m^3. Maximum concentration was 28.5 ug/m^3.

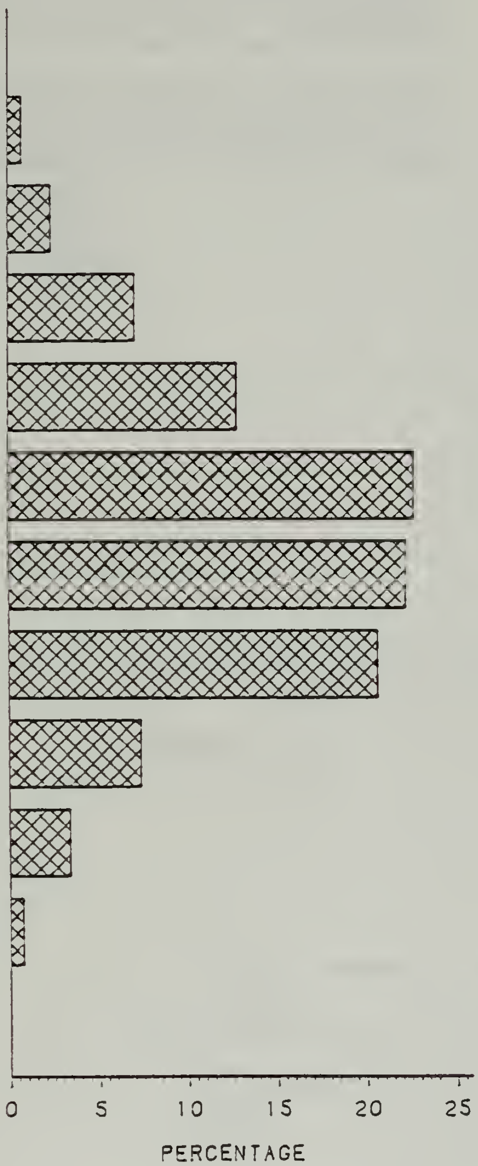
No significant short or long term trends exist in the air quality data except for CO. CO exhibits a negative trend which is attributed to instrument changes throughout the history of the monitoring period. The CO instrument used during baseline and shortly thereafter was relatively inaccurate and yielded high readings. This instrument has been replaced twice, and CO readings have dropped as instrument accuracy has improved.

Quality assurance audits were conducted quarterly in 1984. One was conducted by the State of Colorado, and one by the EPA, Region VIII and two by an independent consultant. In every case, all CB gaseous instruments were within $\pm$ 7% of the audit instrumentation and particulates were within $\pm$ 13%. Details are given in the 6-month data reports to the OSPO.

FIGURE 9-10

HISTOGRAM OF HOURLY OZONE CONCENTRATIONS

1984



RANGE OF CONCENTRATION (UG/M3)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
<20	1	1	0.01	0.01
20-29.9	63	64	0.74	0.76
30-39.9	202	266	2.39	3.14
40-49.9	601	867	7.10	10.24
50-59.9	1082	1949	12.78	23.02
60-69.9	1919	3868	22.66	45.68
70-79.9	1882	5750	22.22	67.90
80-89.9	1748	7498	20.64	88.55
90-99.9	623	8121	7.36	95.90
100-109.9	286	8407	3.38	99.28
110-139.9	61	8468	0.72	100.00
≥140	0	8468	0.00	100.00

Yearly Mean = 71.2 ug/m^3

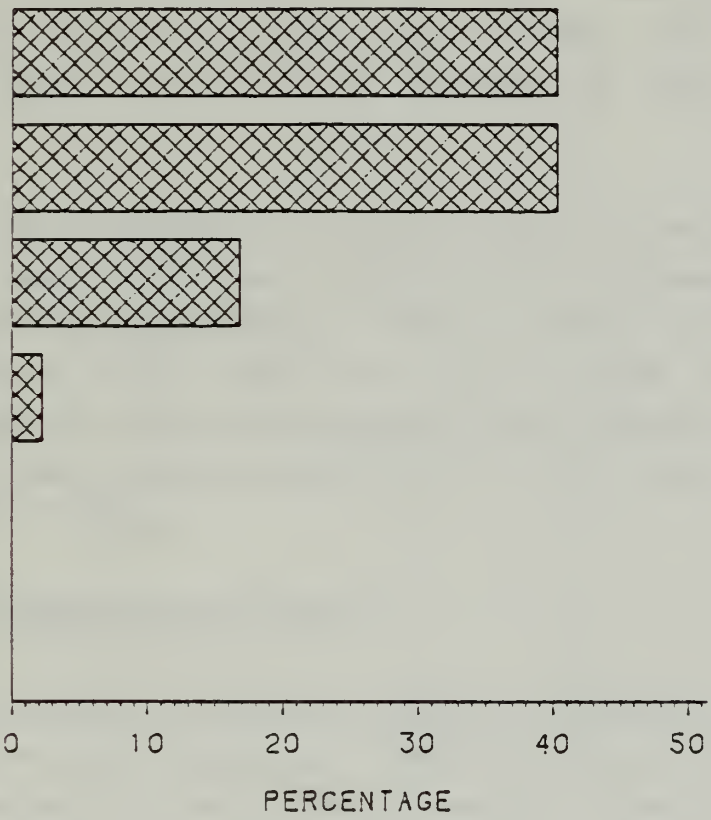
Five highest concentrations for 1984:

135.4	ug/m^3	6/11/84 @ 1300 hr.
131.5	"	5/28/84 @ 1400 "
129.5	"	5/28/84 @ 1500 "
129.5	"	6/10/84 @ 1100 "
129.5	"	6/10/84 @ 1200 "

FIGURE 9-11

Histogram of 24-Hour Particulate Concentrations

1984



RANGE OF CONCENTRATION (UG/M^3)	FREQ	CUM. FREQ	PERCENT	CUM. PERCENT
0 - 4.9	36	36	40.45	40.45
5 - 14.9	36	72	40.45	80.90
15 - 24.9	15	87	16.85	97.75
25 - 34.9	2	89	2.25	100.00
>35	0	89	0.00	100.00

Annual Geometric Mean = 4.6 ug/m^3

Five Highest Concentrations for 1984:

28.5 ug/m^3 @ 6/27/84
25.5 " @ 5/10/84
23.6 " @ 5/26/84
22.5 " @ 6/15/84
22.5 " @ 9/07/84

Table 9-7 shows mean seasonal visual range and annual visual range for all years since 1975. These are values obtained from the telephotometric method with "equivalent" data utilized in 1975-1978 using contrast threshold of the eye, C_m = 0.05, as described in last year's Annual Report. Figure 9-12 is a histogram of daily mean visual range for 1984. Mean annual visual range for 1984 was 76 miles; for 1983 it was 78 miles; the annual average since 1975 was 84 miles.

It is of interest to note the comparison between the observer's estimated visual range (O) and that obtained from the telephotometer (M). For the entire 1984 data set (18 samples) for view 1 at 0830 am, 1130 am and 1400 pm the percent differences ($\frac{O-M}{M}$ x 100%) are -21, -16, and -16 respectively. Observer estimates are shorter than measured values primarily due to the fact that the farthest away target is only 54 miles in this view, i.e., closer than the measured visual range.

9.3.6 Meteorology and Climate

Climatological parameters measured include wind speed and direction, temperature (and delta temperature from 60 to 10m), solar radiation, precipitation, relative humidity, and barametric pressure. These records serve as a historical data base to assess climatological effects on the biotic portion of the ecosystem so they may subsequently be sorted from potential man-induced effects. Hourly values are reported in the 6-month data reports.

The wind data are also used to obtain Pasquill-Gifford atmospheric stability and wind persistence information for use in air diffusion modeling studies. Figure 9-13 is the annual wind rose for 1984. Prevailing winds on-Tract continued to be from the SSW. Those in Piceance Creek are constrained to follow the valley walls. Tract C-b's stability classes generally range from stable (i.e., Classes E and F) to neutral (Class D).

Precipitation for Water Year 1984 was approximately 18.9 inches, a wet year in comparison to other recorded years. See Figures 9-2a and 9-2b for comparisons of monthly precipitation for 1980 (a dry year) and 1984 at both Little Hills and C-b Station 023. Seven years of monthly precipitation from 1977-1984 (79 sample pairs) (see Table 9-8) were used to obtain the linear regression between these

TABLE 9-7

Mean Seasonal and Annual Visual Range
1975 - 1984
(Miles)(1)

		VIEW				
		1	2	3	4	All Views
Year	Season	Visual Range	Visual Range	Visual Range	Visual Range	Visual Range
1975*	Spring	-	-	-	-	-
	Fall	94	79	84	95	88
	Yearly	94	79	84	95	88
1976*	Spring	78	70	-	81	76
	Fall	-	-	82	-	82
	Yearly	82	72	73	84	78
1978*	Spring	84	76	72	86	80
	Fall	97	77	69	87	82
	Yearly	89	76	71	86	81
1979	Spring	80	71	79	115	86
	Fall	99	78	95	131	101
	Yearly	90	75	87	123	94
1980	Spring	81	68	78	107	83
	Fall	94	76	81	113	91
	Yearly	87	72	80	110	87
1981	Spring	71	66	67	94	74
	Fall	82	72	83	102	85
	Yearly	77	69	75	99	80
1982	Spring	80	75	81	110	86
	Fall	92	80	90	119	95
	Yearly	87	78	86	115	91
1983	Spring	82	70	61	74	72
	Fall	95	79	70	91	84
	Yearly	88	75	65	82	78
1984	Spring	81	75	70	106	83
	Fall	76	69	58	74	69
	Yearly	79	72	64	90	76
All Years	Spring	80	71	73	97	80
	Fall	91	76	79	102	87
	Yearly	86	74	76	100	84

* Data are estimated "equivalent" telephotometric values.

(1) All historical data have been corrected using $C_m = 0.05$ as explained in the text.

FIGURE 9-12

Daily Mean Visual Range

1984

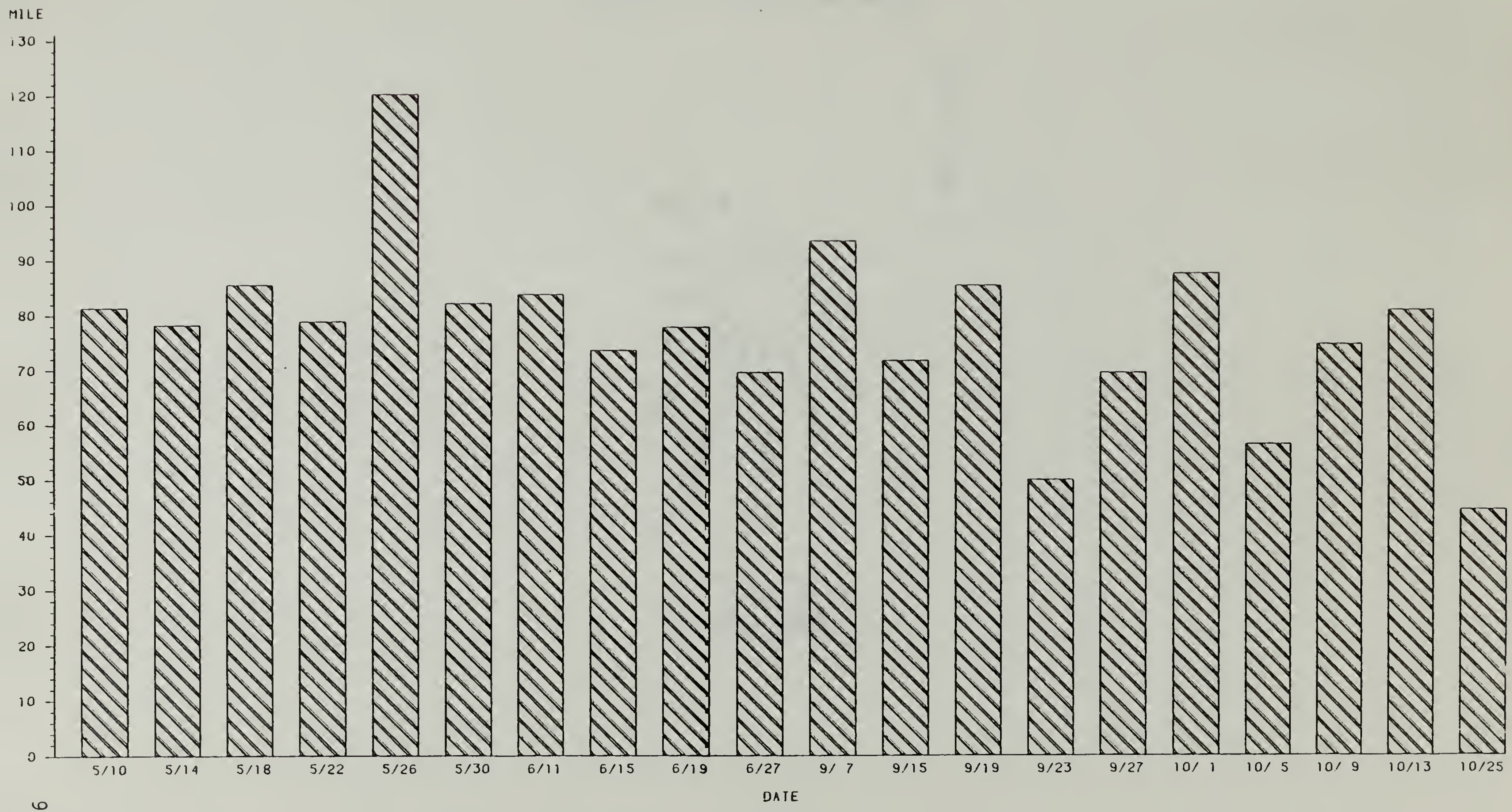


FIGURE 9-13

AA23 ANNUAL WIND ROSE at 10M
JAN '84 - DEC '84

TOTAL % OF CALMS DISTRIBUTED (0.00%)
TOTAL NO OF 1-HOUR SAMPLES=8632

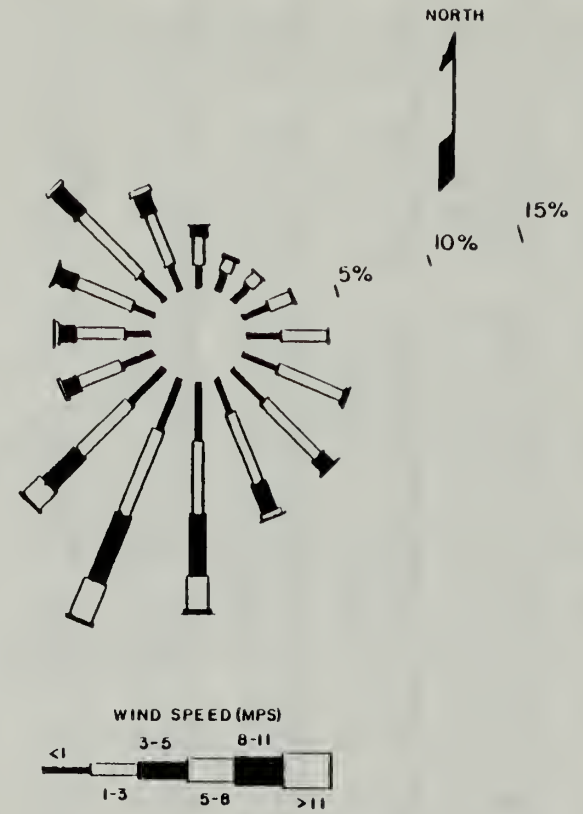


TABLE 9-8

Precipitation (in.) for C-b and Little Hills 1975-1984

Station	Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
C-b Sta. 023	1975	F0.71	F0.40	F1.15	F1.53	F2.32	F1.71	F3.02	F0.25	F0.63	F1.50	F0.66	F0.69	F14.57
Little Hills		0.80	0.50	1.22	1.58	2.33	1.75	3.00	0.36	0.72	1.55	0.75	0.78	15.34
C-b Sta. 023	1976	F0.36	F0.65	F1.60	F1.13	F1.93	F1.55	F1.00	F1.75	F1.14	F0.44	F0.0	0.39	F11.94
Little Hills		0.47	0.74	1.65	1.20	1.96	1.60	1.08	1.79	1.21	0.54	0.10	0.10	12.44
C-b Sta. 023	1977	0.80	0.53	1.58	1.25	1.10	0.16	1.85	2.23	1.47	0.88	1.44	0.85	14.14
Little Hills		0.26	0.44	0.95	0.87	0.71	0.29	1.19	2.26	0.91	1.22	1.25	0.70	11.05
C-b Sta. 023	1978	0.65	1.04	3.29	0.90	1.55	0.51	0.78	F0.38 M0.19	0.55	0.08	1.77	0.36	F11.86
Little Hills		1.16	0.70	2.01	2.18	1.40	0.28	0.76	0.49	0.98	0.20	1.68	1.48	13.32
C-b Sta. 023	1979	1.07	0.62	1.51	1.17	3.34	0.38	0.85	0.86	0.28	1.83	2.10	0.45	14.46
Little Hills		0.93	0.61	2.45	1.02	2.53	0.32	0.28	1.30	0.25	1.56	1.66	0.39	13.30
C-b Sta. 023	1980	1.12	1.39	2.26	0.88	F2.78 M0.89	0.06	F1.32 M0.65	0.76	0.37	1.17	0.68	0.37	F13.16
Little Hills		1.15	1.61	2.07	E0.65	2.77	0.03	1.38	1.81	0.81	1.20	E0.68	0.33	E14.49
C-b Sta. 023	1981	0.66	0.34	1.26	0.60	2.45	1.33	1.26	0.71	1.17	3.05	0.25	1.18	14.26
Little Hills		0.20	0.76	2.82	0.23	3.20	1.11	1.44	1.07	0.44	4.32	0.54	1.09	17.22
C-b Sta. 023	1982	0.88	F0.69 M0.69	F0.79 M0.56	0.81	1.83	F0.57 M0.57	F1.03 M1.03	2.51	2.94	F1.59 M0.71	1.28	0.98	F15.90
Little Hills		0.76	0.48	0.88	0.43	2.16	0.39	0.85	1.22	3.81	M1.64	M1.13	0.84	M14.59
C-b Sta. 023	1983	F0.15 M	F0.96 M	F1.60 M	F1.85 M	F3.26 M	1.90	1.33	0.80	0.37	1.24	1.23	1.46	F16.15
Little Hills		0.27	1.04	1.65	1.89	3.23	2.48	1.85	1.52	0.73	2.18	1.51	1.83	20.18
C-b Sta. 023	1984	0.65	0.61	1.90	1.96	1.34	3.25	0.91	2.84	1.50				
Little Hills		0.46	0.63	2.09	2.84	0.48	3.84	0.60	3.00	1.78				

M = Missing Data
E = Estimated, Little Hills (by Little Hills)
F = Estimated for C-b from regression

Regression: $y = a + bx = 0.12 + 0.95x$ or $x = 1.05y - 0.13$
y = Little Hills monthly precipitation (in.)
x = C-b Station 023 monthly precipitation (in.)
79 sample pairs
r^2 = Coefficient of Determination = 0.65

two stations. The equation is given at the bottom of the table: the coefficient of determination (r^2) is 0.65. The regression equation was then used to estimate missing values for Station 023 as indicated in the table.

9.3.7 Noise

The environmental noise program was discontinued during the Interim Monitoring Period.

9.3.8 Wildlife Biology

The wildlife monitoring program for 1984 consisted of studies on mule deer, lagomorphs, raptors, browse and mitigation projects. Small mammal trapping was not conducted this year (with approval from the OSPO).

A bite count study and a fecal analysis study are being conducted instead of the trapping program. These two studies are being conducted to aid in determining the food preference of mule deer in the C-b Tract area. These data used in conjunction with other wildlife studies will hopefully provide information regarding deer dietary needs to allow improved reclamation planning.

9.3.8.1 Mule Deer

9.3.8.1.1 Pellet-Group Counts

Pellet group counts were conducted along 43 transects: 16 in chained rangeland habitat, 12 in pinyon-juniper habitat, 9 in brush-beaten sage and 6 in brush-beaten serviceberry. These counts are conducted to monitor distributions of wintering deer on and in the near vicinity of Tract C-b.

A 2-level nested analysis of variance was used to evaluate differences in the pellet-group densities between brush-beaten and control areas. A logarithmic transformation was used to correct for positive skewness.

The pellet-group monitoring results presented (Figures 9-14 and -15) incorporate data from the past 7 years (1977-78 through 1983-84). The figures were designed to make the following situations conspicuous should they occur: 1) a

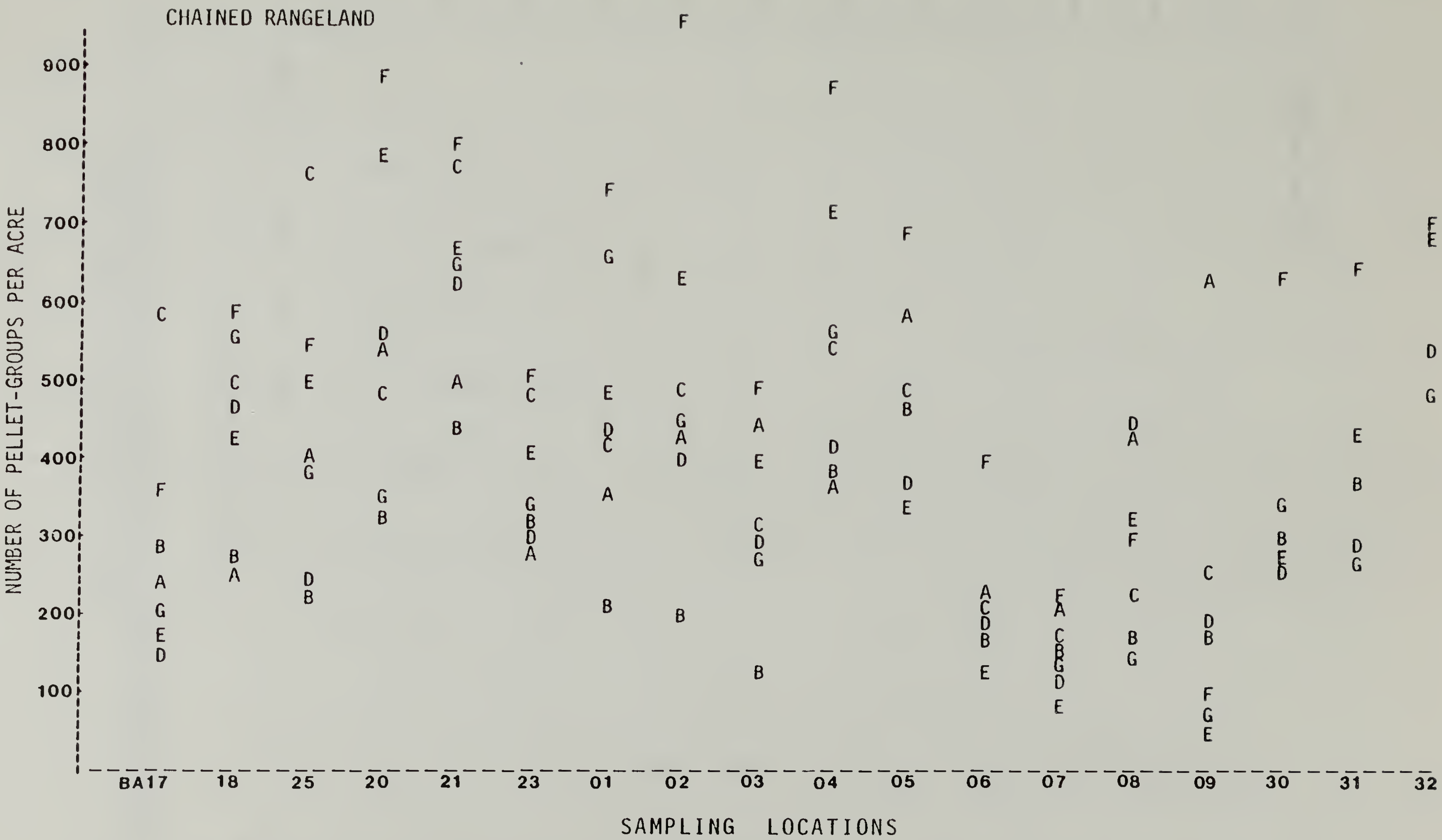


FIGURE 9-14 Mule Deer Pellet-Group Densities in Chained Rangeland Habitat. Letters correspond to the following years: A=1978; B=1979, C=1980; D=1981; E=1982; F=1983; G=1984

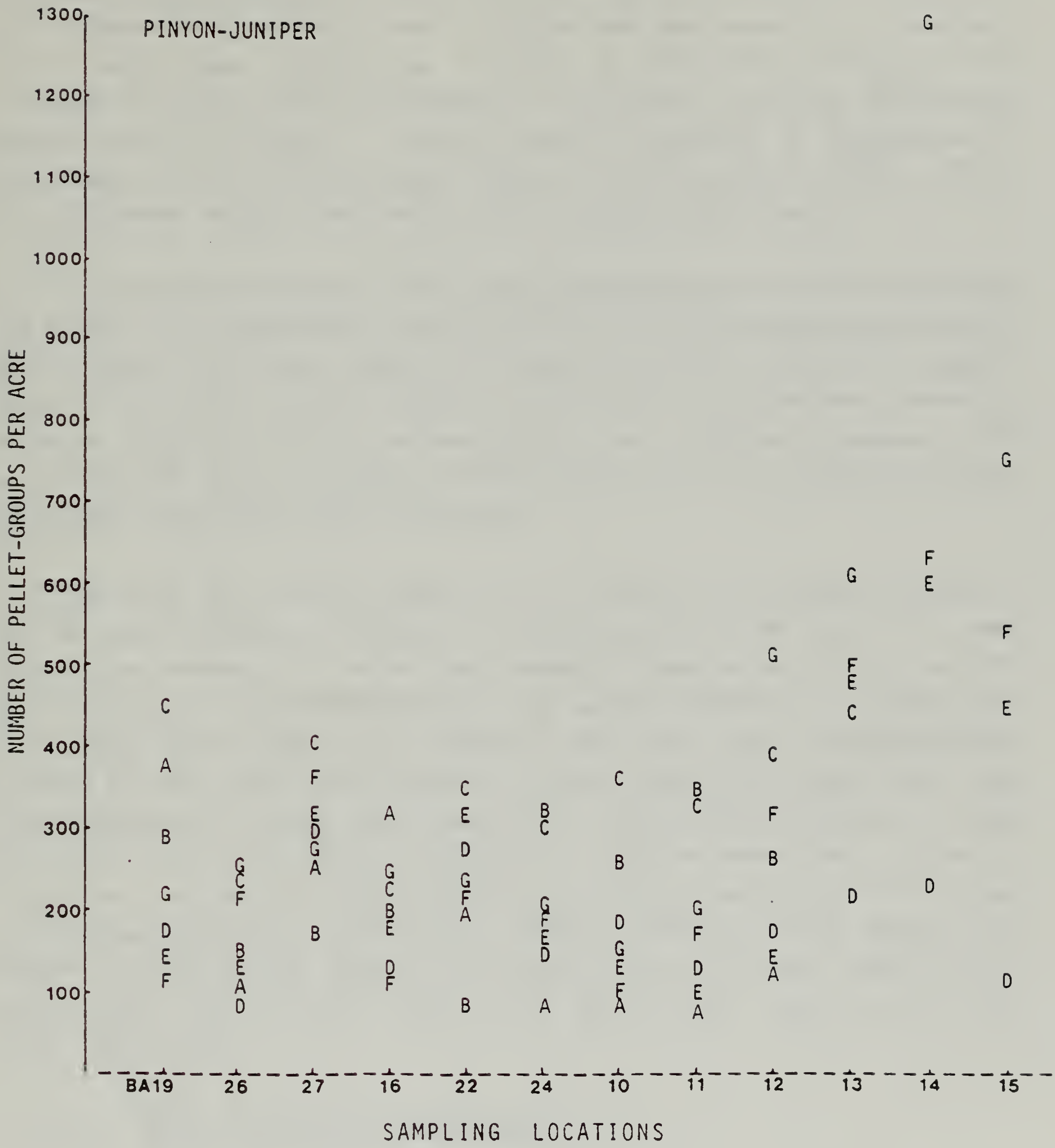


FIGURE 9-15 Mule Deer Pellet-Group Densities in Pinyon-Juniper Habitat. Letters correspond to the following years: A=1978; B=1979; C=1980; D=1981; E=1982; F=1983; G=1984.

trend toward lower pellet-group densities at transect locations close to development activities, accompanied by higher densities at control locations (indicative of a permanent displacement of deer from areas near development); 2) a temporary shift toward lower pellet-group densities at localized disturbance sites (indicative of short-term displacements); 3) a return to previous pellet-group density levels following a localized impact (indicative of habituation to disturbance); and 4) any consistent pattern in the data that provides insight into the manner in which deer use the area on a year-to-year basis.

The discussion contained in the 1982 CB Annual Report provided an example of the statistical procedure that can be used to evaluate suspected displacements of deer (impacts or increased usage) near transect locations. Following an examination of these years' results, however, displacements are not evident; therefore, there is no justification for implementation of the statistical procedure. Data on pellet-group density estimates for this past year at all transect locations were shown in the January 1985 Data Report.

Studies of elk have never been part of C-b monitoring, because evidence of elk has been infrequently detected in close proximity to the Tract. It seems appropriate, however, to mention that, recently, observations of elk near the Tract and along the Piceance Creek road have markedly increased. This past year, for example, small groups of elk (generally less than eight; the biggest group totaled 23) were seen on 20 separate occasions along the Piceance Creek road while conducting deer road count observations. Most of the sightings were near the White River (miles 36-41), although four sightings were within 5 miles of Tract C-b. As well, elk pellet-groups were found along 16 of the 43 deer pellet-group transects. The transect numbers (omitting the BA prefix) with number of pellet-groups shown in parentheses are as follows: 04(4); 07(1); 08(3); 09(4); 15(1); 17(5); 19(4); 21(1); 25(1); 27(3); 48(2); 51(2); 52(5); 53(3); 55(3); 56(4).

9.3.8.1.2 Browse Production and Utilization

Studies on bitterbrush production and utilization were conducted along 19 transects in two habitat types: chained rangeland (13 transects) and pinyon-

juniper (6 transects). The study is designed to estimate current annual growth available to deer and percent utilization of the yield.

Summaries of the past 6 years of bitterbrush investigations (Figures 9-16 and -17) have been presented using a format similar to that for summarizing deer pellet-group data. Estimates of the degree of hedging--length of shoots remaining after winter browsing--for this past year (1983-84), as well as those for production and percent utilization, were presented in the January 1985 Data Report. Inspection of Figures 9-16 and -17 suggests no departures for 1983-84 data from the typical pattern of browse utilization. Utilization this past year tended to be intermediate in terms of the range of variation encountered over the past 7 years. Therefore, no analyses of differences were performed.

Rodents caused heavy damage to bitterbrush shrubs during the winter. Casual observation showed that almost every transect had rodent damage. Several shrubs were killed by the damage.

9.3.8.1.3 Sagebrush Utilization

Sagebrush utilization was based on ocular estimations along 25 transects. Both bitterbrush and sagebrush studies are valuable in characterizing browse intensity as well as utilization. They also provide a second approach (to deer pellet-group counts) for detecting development-induced changes in the distribution of the local deer populations.

Sagebrush ocular estimates for 1978-84 are listed in Table 9-9. Sagebrush utilization rates in both chained pinyon-juniper and pinyon-juniper habitats are decreasing. However, comparisons of these data with past data indicate that activities on C-b Tract are probably not affecting sagebrush growth or utilization rates.

9.3.8.1.4 Migrational Phenology, Off-Site Deer Abundance and Age-Class Composition

Migrational phenology data are collected by obtaining deer counts along the entire Piceance Creek Highway (42 miles). The objective of the study is to

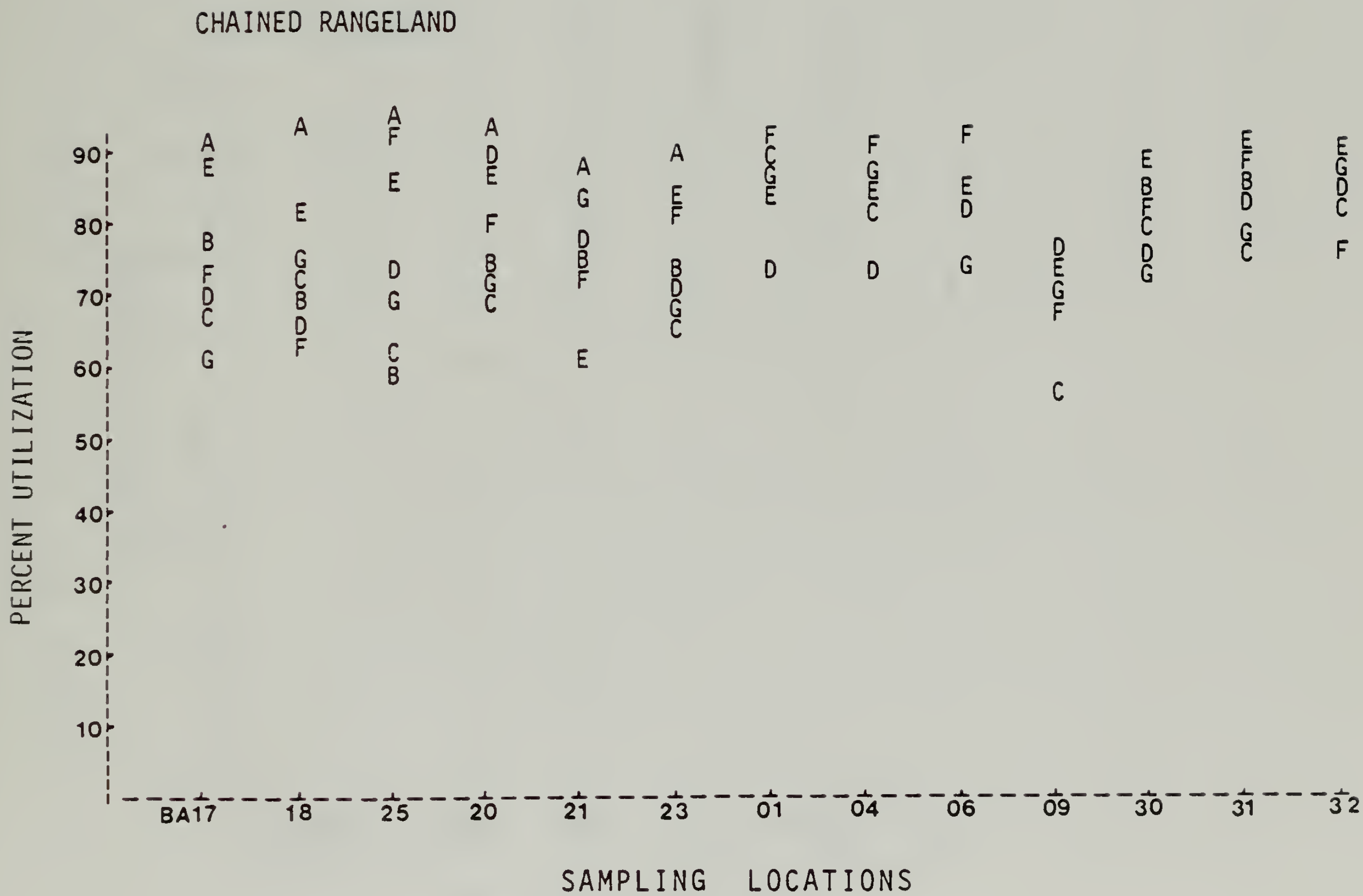


FIGURE 9-16 Percent Utilization of Bitterbrush by Mule Deer in Chained Rangeland Habitat. Letters correspond to the following years: A=1978; B=1979; C=1980; D=1981; E=1982; F=1983; G=1984.

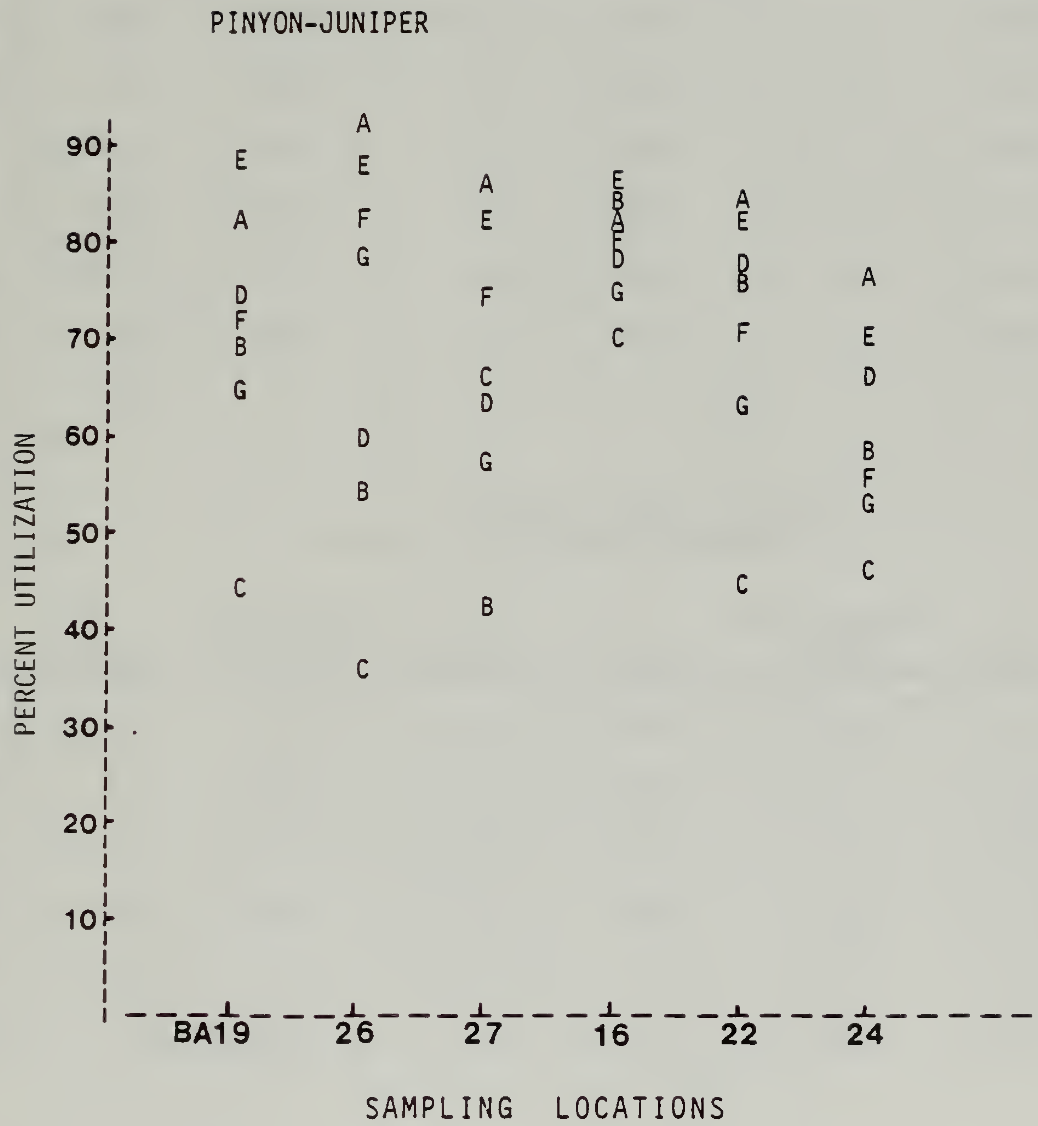


FIGURE 9-17 Percent Utilization of Bitterbrush by Mule Deer in Pinyon-Juniper Habitat. Letters correspond to the following years: A=1978; B=1979; C=1980; D=1981; E=1982; F=1983; G=1984.

TABLE 9-9

Sagebrush Ocular Estimate
1978 - 1984

CHAINED PINYON JUNIPER HABITAT

Year	Growth Form Young	Growth Form Mature	Growth Form Decadent	Utilization Low	Utilization Medium	Utilization High	Shrub Density
1984	20.3	76.0	3.7	92.6	7.1	0.3	313
1983	16.8	82.3	0.9	90.3	9.7	0.0	341
1982	20.3	78.5	1.2	82.0	17.5	0.5	338
1981	28.8	68.6	2.6	64.9	32.0	3.1	259
1980	19.5	73.3	6.2	54.0	40.0	6.0	339
1978	7.2	88.0	4.8	41.9	39.3	18.8	309

PINYON JUNIPER HABITAT

Year	Growth Form Young	Growth Form Mature	Growth Form Decadent	Utilization Low	Utilization Medium	Utilization High	Shrub[1] Density
1984	1.4	73.2	25.4	69.1	28.0	2.9	75
1983	1.1	78.9	20.0	56.6	35.1	8.3	76
1982	1.1	70.3	28.6	49.4	42.0	8.6	79
1981	1.4	76.2	22.2	45.9	40.0	14.1	97
1980	2.3	52.4	45.3	17.7	38.7	43.6	98
1978	0	48.6	51.4	5.8	40.4	53.8	88

[1]Sagebrush plants/acre = $\frac{\text{Number of shrubs counted}}{\text{Number of sample points}}$ X Basal Area Factor

Basal Area Factor = 40

monitor deer distributions along the highway in order to detect displacements of deer adjacent to Tract C-b.

The age class study is conducted within a 5 mile area of Tract C-b. The data collected are used to determine fawn-adult ratios in the fall and in the spring.

Migrational phenology and off-site deer abundance, as estimated by road count observations, have been summarized over the past 7 years (Figures 9-18 through 21). Each figure presents results for the same monthly sampling periods to facilitate comparing yearly differences in distributions along the 42 mile length of road. One feature of the patterns that warrants emphasizing is the year-to-year similarity in spatial distributions of deer, particularly for the October, November and April periods. Meadows and other habitats adjacent to the road that are used by deer for one year tend to be the same used in other years. This small amount of variation in habitat occurrence is advantageous for impact detection. Major displacements of deer near Tract C-b, for example, would likely be readily detectable as a conspicuous decline in deer numbers in the vicinity of miles 14 through 21. Tract C-b boundaries are less than 2 miles from the road along this section, and the access road to the Tract occurs at mile 20. It should also be noted that these monitoring data have regional applicability in that a large segment of the Piceance Basin is traversed by the 42 mile road-count transect.

Age class surveys indicate a ratio of 82 fawns per 100 adults (sample size - 123 deer) in November 1983 and 13.6 fawns per 100 adults (sample size - 647 deer) in April 1984. See Table 9-10. Fawn survival was 12% of the total population and 17% of the fawn population. A comparison of C-b's 17% survival to fawn survival from both the DOE study (5%) (60 deer), and DOW data (5%) (basin wide) indicates very low survival rates. It should be noted that sampling technique and sample size varied greatly between studies. As stated in previous reports, small sample size can bias results (i.e., weather conditions and visibility of the deer herd influence age class data). The data are more qualitative than quantitative.

9.3.8.1.5 Roadkills

Roadkill data was collected along the Piceance Creek Highway to quantify the frequency of kills and to evaluate the causal factors involved.

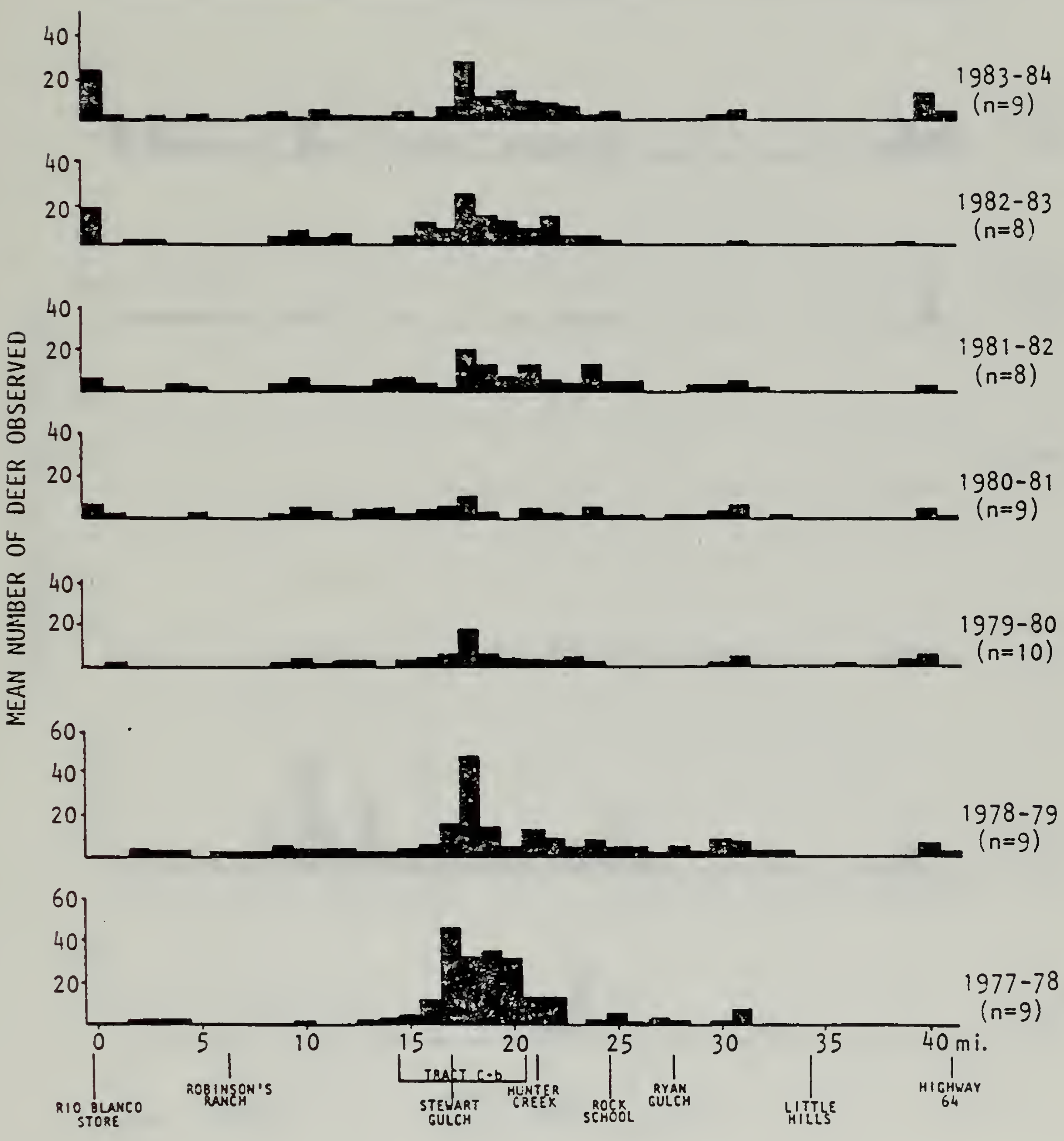


FIGURE 9-18 Summary of Deer Road Counts for the October-November Period. Heights of bars are means; sample sizes (n) are the number of road counts for the period.

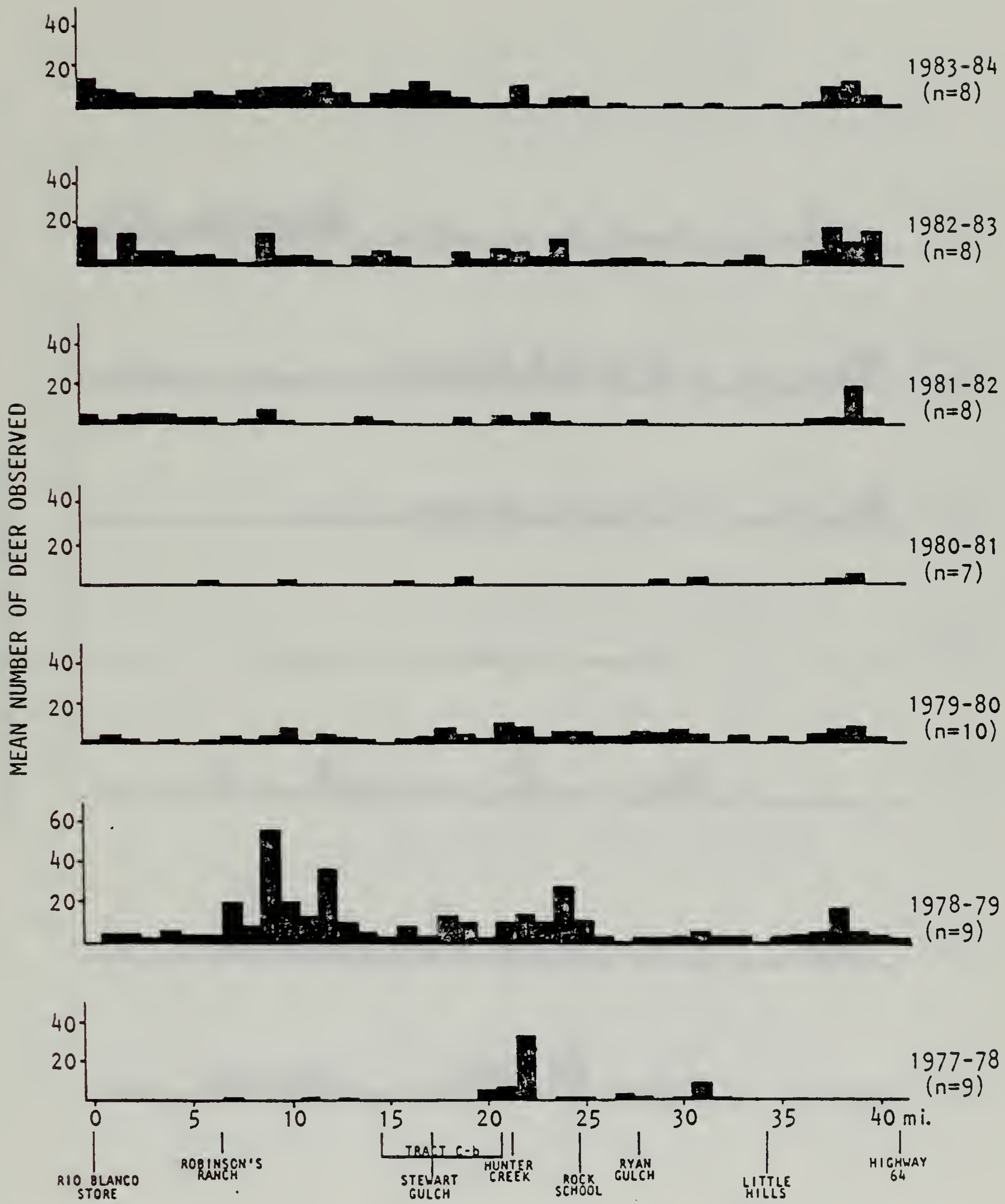


FIGURE 9-19 Summary of Deer Road Counts for the December-January Period. Heights of bars are means; sample sizes (n) are the number of road counts for the period.

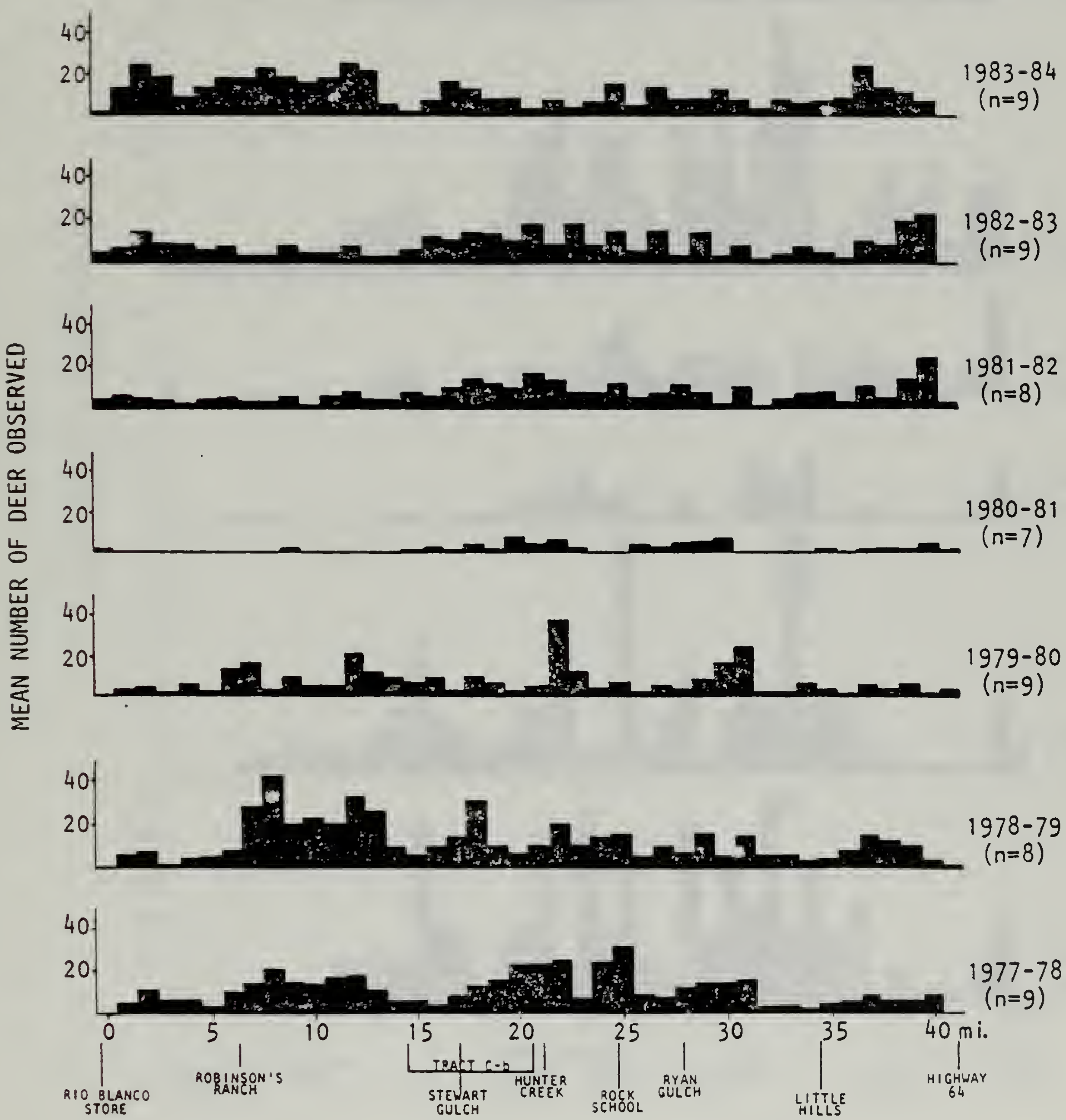
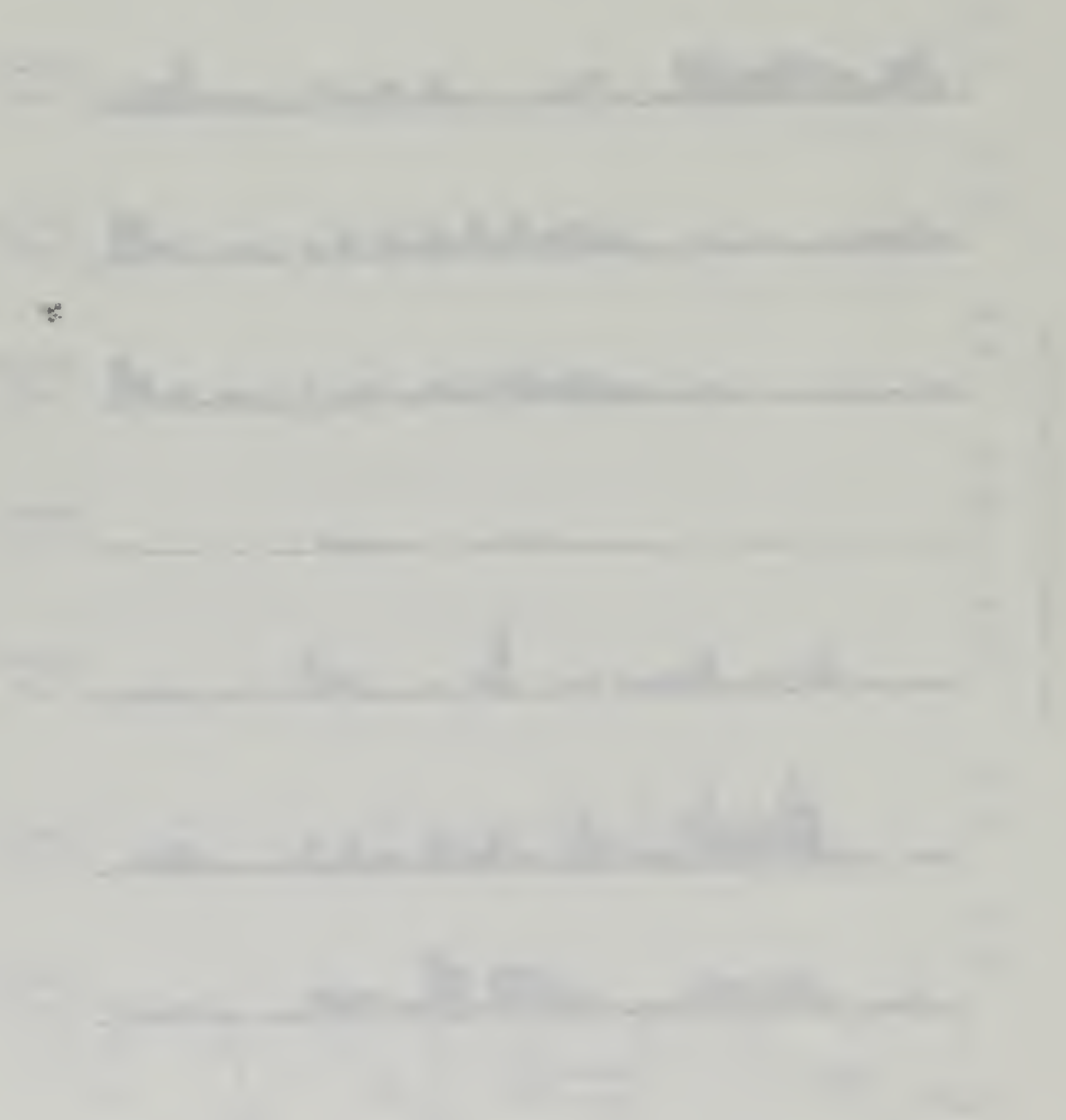


FIGURE 9-20 Summary of Deer Road Counts for the February-March Period. Heights of bars are means; sample sizes (n) are the number of road counts for the period.



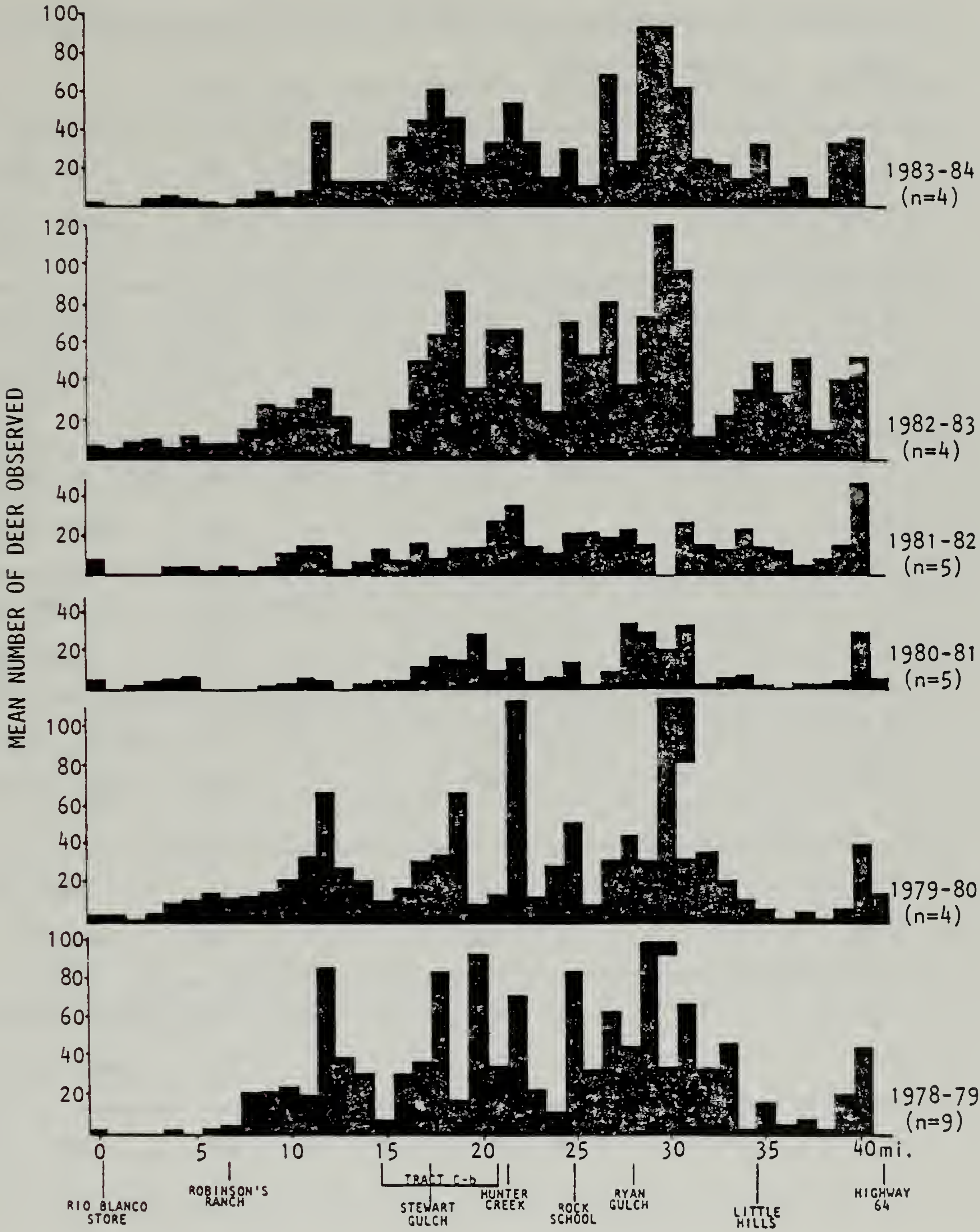


FIGURE 9-21 Summary of Deer Road Counts for the April Period. Heights of bars are means; sample sizes (n) are the number of road counts for the period.

TABLE 9-10 Age Class Composition of Mule Deer Wintering Near Tract C-b.

Date	Fawns	Does	Bucks	Adults	Fawns/ 100 Does	Bucks/ 100 Does	Fawns/ 100 Adults
Nov. 15-23, 1977	85	107	28	135	79.4	26.2	63.0
Apr. 04-07, 1978	68			104			65.0
Nov. 13-27, 1978	151	159	35	194	95.0	22.0	77.8
Apr. 20-26, 1979	41			343			12.0
Nov. 27-Dec. 7, 1979	46	62	8	70	74.1	12.9	65.7
Apr. 21-24, 1980	26			375			6.9
November 1980	No count						
April 25, 1981	24			68			35.2
Nov. 30-Dec. 4, 1981	27	31	2	33	87.1	6.5	81.8
April 13-14, 1982	204			334			61.1
Dec. 2-6, 1982	51	78	13	91	65.0	23.0	56.0
April 7-14, 1983	148			524			28.0
Nov. 26-Dec. 5, 1983	101	106	17	123	95.3	16	82.1
April 22-23, 1984	88			647			13.6
Dec. 4-6, 1984	40	69	5	74	60.6	7.2	54.1

. total of 65 deer were killed by vehicles along the Piceance Creek road during the 1983-84 study period (Table 9-11). Traffic load on the road was similar to the two previous years.

The total roadkills recorded for the past seven years are 534 deer. Figure 9-22 summarizes results by mile marker. The class breakdown is 52% does, 22% female fawns, 16% male fawns, 6% bucks, and 4% unknown (carcass removed before age and sex information could be collected). Minimal 1984 C-b activities do not seem to be affecting the deer/vehicle collisions on the Piceance Creek road.

9.3.8.1.6 Natural Mortality

Natural mortality data were collected in 4 sagebrush draws north of C-b Tract. The main objective of the study is to document yearly trends which aid interpretations of other monitoring data.

Thirteen deer carcasses were identified within the mortality study plots for the 1983-84 period (Table 9-12). This represents an estimate of 0.44 carcasses per hectare for sagebrush-lateral-draw habitats in the vicinity of Tract C-b. The average number of carcasses estimated for the preceding 8 years of sampling is 0.57 per hectare. Care should be taken in comparing these data since the deer population has fluctuated greatly over the past 8 years. However, the 1983-84 mortality figures were significantly higher than the mortality from the previous two years. Higher mortality was indicative of the difficult winter conditions that existed in 1983-84. The CDOW had a large feeding program in Western Colorado (not in the Piceance Basin).

9.3.8.2 Lagomorph Abundance

Cottontail and jackrabbit abundance studies were conducted on the deer pellet-group transects. The studies were directed toward documenting trends in levels of abundance and aiding in impact detection. Pellet frequency data for both cottontails and jackrabbits were given in the January 1985 Data Report.

Cottontail pellet count data for the past 4 years (Table 9-13) yield preliminary analyses regarding the preferred habitats of cottontails and their

TABLE 9-11

Piceance Creek Road Kill
(Piceance Creek Road from 0 thru Mile 41)

Date	Does		Fawns				Bucks		Unknown	Total
			Male		Female					
	No.		No.	%	No.	%	No.	%		
9-83 to 5-84	39	60	8	14	11	17	3	5	4	65
9-82 to 5-83	35	58	8	13	15	23	0	0	2	60
9-81 to 5-82	30	56	3	6	12	22	6	12	3	54
9-80 to 5-81	12	43	3	11	6	22	2	7	5	28
9-79 to 5-80	40	41	22	22	26	27	3	3	5	96
9-78 to 5-79	80	61	13	10	27	21	11	8	0	131
9-77 to 5-78	40	41	28	29	22	22	8	8	2	100*
TOTALS	276	52	85	16	119	22	33	6	21	534

*Total road kill was 125 deer. This figure was derived from combining DOW data with C-b data.

FIGURE 9-22

Cumulative Piceance Creek Road Kill (1977 - 1984)

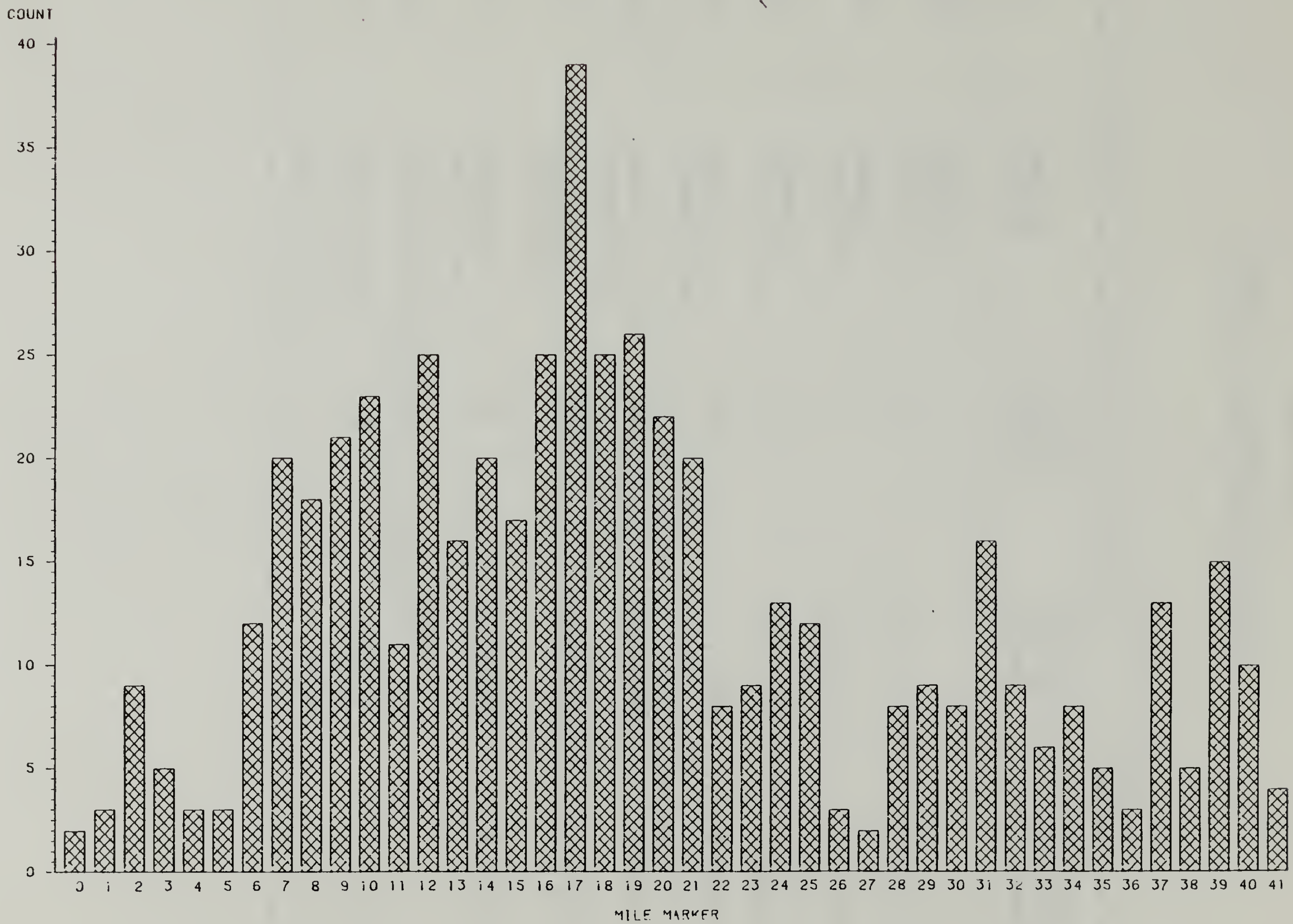


TABLE 9-12

Results of Deer Mortality Studies

Year	Sampling Location	No. of carcasses found	Hectares sampled (acres)	Carcasses per hectare (/acre)
1983-84	Sagebrush lateral draw	13	29.5(73)	0.4 (0.18)
1982-83	Sagebrush lateral draw	3	29.5(73)	0.10(0.04)
1981-82	Sagebrush lateral draw	2	70.5(174)	0.03(0.01)
1980-81	Sagebrush Internal draw	16	70.5(174)	0.2 (0.1)
1979-80	Sagebrush Internal draw	60	70.5(174)	0.9 (0.3)
1978-79	Sagebrush-lateral draw	34	70.5(174)	0.5 (0.2)
1977-78	Sagebrush-lateral draw	25	70.5(174)	0.4 (0.1)
1976-77	Interim monitoring period - No sampling			
1975-76	Lateral draws	8	7.25(18)	1.1 (0.4)
1974-75	Lateral draws	11	7.25(18)	1.5 (0.6)

TABLE 9-13 Cottontail Trends Based on Pellet Count Frequencies.[1]

Year	HABITAT Chained rangeland	Pinyon-juniper	Brush-beaten sagebrush	Sagebrush control
1978-79	8+/-1.2 (18)	11+/-1.6 (12)	-	-
1979-80	12+/-0.9 (15)	11+/-1.3 (12)	-	-
1980-81	9+/-0.7 (18)	13+/-0.8 (12)	3+/-0.9 (4)	12+/-3.1 (5)
1981-82	7+/-1.0 (18)	11+/-1.4 (12)	1+/-0.4 (4)	9+/-2.7 (5)
1982-83	13+/-1.0 (18)	15+/-0.8 (12)	3+/-1.3 (4)	14+/-2.1 (5)
1983-84	16+/-0.6 (15)	15+/-1.0 (12)	6+/-0.9 (4)	17+/-1.7 (5)

1 Data are means +/-SE (n). Means are based on the number of quadrats with droppings present; n = number of transects. A transect is 20 circular quadrats, 0.001 acre each.

possible usefulness as a biomonitoring species. The relative abundance of cottontails in the four habitat types sampled, as estimated by pellet counts appears to be greatest in sagebrush ($x = 17.2$), least in brush-beaten sage ($x = 5.8$), and intermediate in the chained and pinyon-juniper habitats ($x = 10.8$ and 12.7 respectively). Differences between chained and pinyon-juniper, when evaluated using a t-test, were nonsignificant ($P>0.20$). As well, a significant correlation exists ($P>0.10$) between chained and pinyon-juniper habitat types, which suggests that yearly trends in cottontail abundance are reflected similarly in these two habitats.

9.3.8.3 Small Mammals

Studies were not performed on small mammals during 1984. This monitoring program has been temporarily stopped to allow time for development of a mule deer food-preference study. Results of this substitute monitoring program will be discussed next year.

9.3.8.4 Raptor Activity

All raptor nests in the general area of C-b Tract were checked for raptor activity. The raptors are monitored to detect changes in raptor utilization around the Tract.

A total of 14 nests showed various amounts of raptor activity. Nine young were fledged from 5 nests during the study period. The young included two golden eagles, two great horned owls, and five red-tailed hawks. Several other raptor species were observed in the C-b Tract vicinity during 1984, including kestrels, a short-shinned hawk, a bald eagle, golden eagles, and numerous ravens.

An unusual sighting of a snowy egret was recorded on the Oldland pond.

No threatened or endangered plant or wildlife species were observed on Tract. As usual bald eagles were observed in the Tract study area.

9.3.9 Vegetation

Vegetation monitoring studies have been conducted yearly on the C-b Tract since 1977. These studies have focused on monitoring trends in herbaceous production and changes in community structure and species composition in the four major plant communities on the Tract. By 1982 the only studies continued were the production/utilization measurements in the chained rangeland type, the irrigation and fertilization production studies, and the cover and density studies in the irrigated chained rangeland intensive study plot. In 1984 the production/utilization studies contained only the chained rangeland type (with OSPO concurrence). In addition to these studies, revegetation monitoring studies are also being conducted. These include: evaluation of revegetation success on raw shale, evaluation of revegetation success on processed (spent) shale, evaluation of revegetation success on topsoil stockpiles (expected to resemble revegetation of non-disposal disturbed areas), and evaluation of effects from cattle grazing on revegetated areas. These revegetation studies are discussed in the following Section 9.3.10.

The methods used in conducting and analyzing the 1984 production and utilization field studies were the same as those used in earlier years. The data for these studies are contained in the January 1985 CB Data Report.

Data were obtained for the production and utilization studies from both range cages and adjacent open areas.

Mean total production was 31.0 g/m^2 (277 lbs/ac) in the open areas and 61.9 g/m^2 (553 lbs/ac) inside the range cages. Based on a one-way analysis of variance these two means are significantly different at a 0.05 level of significance. (The critical region for this test occurs when the F-value is greater than 4.21. The calculated F for this test was 10.41.) Based on data from the range cages, the production in the chained rangeland type was comparable to the results obtained in earlier years (Figure 9-23), and was very similar to the value obtained in 1983 (70 g/m^2). Between 1979 and 1982, production ranged between approximately 42 and 46 g/m^2. In 1978, mean production in the chained rangelands was approximately 62 g/m^2. These fluctuations in yearly production are most likely related to yearly precipitation. The last two years (1983 and

[illegible]

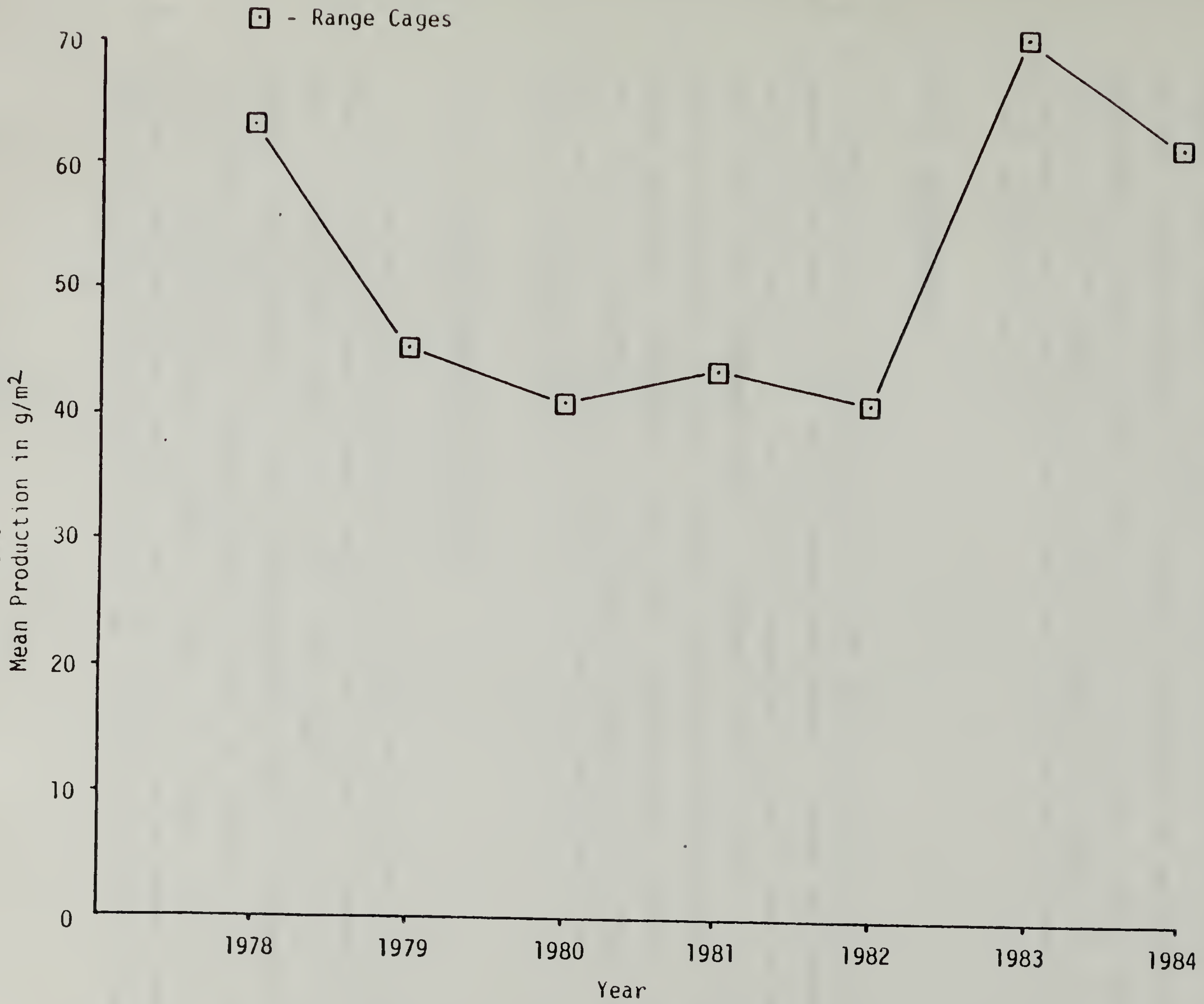


FIGURE 9-23 Trends in Mean Herb Production Between 1978 and 1984 for the Chained Pinyon-Juniper Rangelands.

1984 have had higher than normal precipitation. Another factor that may have some influence on yearly production is the change in location of individual quadrats from year to year.

Utilization of the herbaceous production in the chained rangeland type was approximately 50 percent. This value is consistent with results from the past few years (49.0 percent in 1983 and 43.4 percent in 1982). Since yearly production has increased over the past two years and the percent utilization has remained fairly constant, it appears that total amount of utilization the last two years has also increased. This increase in use could be the results of range improvements on, and in the vicinity of, the C-b Tract. These improvements include water development, which results in better distribution of cattle, and crossfencing, which holds cattle on the late spring and early summer range for a longer period of time.

9.3.10 Revegetation

Revegetation monitoring studies for 1984 were conducted on two revegetation demonstration test plots, and on revegetated topsoil storage embankments. The two test plots include: evaluation of revegetation success of raw (non-retorted) shale under three different topsoil treatments, and evaluation of revegetation success on processed (retorted or spent) shale under different topsoil and sewage sludge application treatments. The topsoil stockpiles were sampled to evaluate the success of revegetation on non-disposal disturbed sites. These sites were also set up in a paired-plot design in order to evaluate effects of cattle grazing on revegetated sites.

9.3.10.1 Raw Shale Demonstration Plot

The raw shale demonstration test plot study was designed to evaluate the effect of three different topsoil depths on the success of revegetation. The study was initiated in the fall of 1981. The demonstration test plot was constructed on the south-facing side of the raw shale stockpile located south of the CB offices. The plot is approximately 5-8 feet in thickness. The plot was covered with three different depths of topsoil (6 inches, 12 inches, and 18 inches). The plot slopes gently to the south with an approximate slope of 1:8. After the topsoil was spread, the plot was broadcast seeded (See January 1984

Data Report for species mixture). After seeding, the plots were mulched with netted fiber matting. During 1982 and 1983, the plot was irrigated on an "as needed" basis with approximately 3 inches of water applied during 1982 and approximately 1 inch in 1983. The plot was fenced to eliminate grazing by domestic livestock. It is interesting to note that the fencing does not exclude rabbits. Observations made during the 1983 and 1984 growing seasons suggest that grazing by rabbits may be influencing the total production values. In the fall of 1982, the entire plot was fertilized with the equivalent of 100 pounds of available nitrogen and 100 pounds of available phosphorus per acre. The fertilizer application was repeated in May 1984 at the same application rates. Limited observations and evaluations of revegetation success were made during the 1982 growing season. Detailed sampling was conducted in 1983 and 1984.

The 1983 and 1984 sampling program consisted of obtaining cover, frequency, species diversity, and production data from each of the topsoil treatments. The sampling methods used are consistent with those used for other cover and production studies on the Tract. Production data were obtained using a double sampling method using 0.1 m^2 quadrats rather than 1.0 m^2 quadrats. The smaller sized quadrats were used because of the small size of the demonstration plot. Cover and production were estimated in 20 quadrats in each of the different treatments. Clipped samples were taken in five of the estimated quadrats.

The data from the test plot were evaluated using a one-way analysis of variance which tested the null hypothesis that there were no significant differences among the mean production values obtained from each of the topsoil treatments.

The 1984 revegetation monitoring data were presented in the January 1985 CB Data Report.

Mean total herbaceous cover was consistent among the three topsoil treatments. Mean total cover ranged from 27.4 percent on the 6-inch topsoil treatment to 27.2 percent on the 12-inch topsoil treatment. Mean cover on the 18-inch topsoil treatment was 30.1 percent. The major species are the wheatgrasses (Agropyron cristatum, Agropyron intermedium, Agropyron spicatum,

and *Agropyron smithii*). The wheatgrasses accounted for 80.5 percent, 75.2 and 79.3 percent of the total cover on the 6-inch, 12-inch, and 18-inch treatments, respectively. The other major species were alfalfa (*Medicago sativa*), smooth brome (*Bromus inermis*), and Russian wildrye (*Elymus junceus*) which accounted for most of the remaining cover on the three treatment blocks. Of the species that were planted, wheatgrasses performed the best. Mountain brome and Great Basin wildrye were not identified in the sampled quadrats in any of the treatments. Alfalfa was the only seeded forb that was encountered in any of the samples. Annual weeds comprised an insignificant component of the vegetation on the test plot.

Mean total production was highest in the 18-inch treatment (115 g/m^2), followed by the 6-inch treatment (89.5 g/m^2) and the 12-inch treatment (88.5 g/m^2). (These weights convert to 1026 lbs/ac, 799 lbs/ac, and 790 lbs/ac, respectively.) It is clear that the gradient of values does not match the topsoil depth gradient; however, the values for the 6-inch and 12-inch treatments are nearly identical. The differences were tested using a one-way analysis of variance and were found to be not significant. (The test was made at an 0.05 level of significance with the critical region for rejecting the hypothesis corresponding to values greater than 3.16. The calculated F value was 2.52.) In 1983, the 18-inch treatment had significantly higher production than either the 6- or 12-inch treatments. The 1984 results show that there is not significant difference among the three different treatments. While the differences measured in 1984 were not significant, it is worthwhile to note that the best results were obtained with the 18-inch topsoil application. These results suggest that 18 inches of topsoil may be preferable; however, the differences are not statistically different after three growing seasons.

In all cases the greatest percent of total biomass was attributable to the wheatgrass species. Crested wheatgrass (*Agropyron cristatum*), beardless bluebunch wheatgrass (*Agropyron spicatum* var. *inerme*) and intermediate wheatgrass *Agropyron intermedium* var. *intermedium* and var. *trichophorum*) were the most productive of the wheatgrass species. Interpretation of the results of the raw shale plot must reflect characteristics of the plant growth medium. Topsoil quality is similar to processed shale plots and topsoil embankments, but below the topsoil is coarse shaft rock with very low water holding capacity. Plants

from the raw shale plot seem to complete growth earlier in the growing season than on other demonstration plots. This results in production being less than that for the processed shale demonstration plot and the topsoil embankments. This is probably a result of the growing medium having less water holding capacity due to coarse texture of subsurface material. Once the limited amount of water stored in the topsoil is utilized, the plants rush to complete their growing cycle and then become dormant.

9.3.10.2.1 1983 Processed Shale Demonstration Plot

The processed shale demonstration plot is designed to evaluate the effect of three different topsoil treatments and the effect of incorporating sewage sludge into the upper layer of the processed shale. The test plot is located in an excavated portion of the rock disposal embankment southwest of the CB offices. Three sides of the plot are contained by the excavations into the rock disposal embankment. The fourth side is supported by a wall constructed of plywood supported by a rock and soil berm. Before the processed shale was placed in the excavated site, the bottom of the pit was sloped to one corner, the bottom was covered with a mixture of soil fines and bentonite clay, and then the entire plot (walls and bottom) were lined with a plastic sheet liner. A plastic pipe was installed in the low corner to serve as a drain for collection of leachate. The drain extends under the retaining wall and berm and empties into a collection container.

The test plot is approximately 45 feet long by 16 feet wide. The treatments in the plot were created by first placing approximately 60 tons of processed shale on the plot. When spread, the shale was approximately 3.5 feet thick. The processed shale was then fertilized with the equivalent of 100 pounds of available phosphorus per acre. The plot was then divided into equal halves along a north-south axis. On one half of the plot, a 6-inch layer of sewage sludge from the Glenwood Springs treatment plant was applied. The sludge was then mixed into the top 5-6 inches of the processed shale using a roto-tiller. The two halves of the plot were then divided into thirds and three different amounts of topsoil (6 inches, 12 inches, and 18 inches) were placed over the processed shale. This design produced six different treatments: 6 inches, 12 inches, and 18 inches of topsoil with 6 inches of sewage sludge incorporated into the processed shale; and

6 inches, 12 inches, and 18 inches of topsoil with no sewage sludge incorporated into the processed shale. Each of the treatment blocks within the test plot is approximately 8 feet by 15 feet in size. The bottom surface of the plot is gently sloping, and the top of the processed shale was stepped in such a manner so as to keep the surface of the plot level and still incorporate the various sludge and topsoil depth treatments.

After the plot was covered with topsoil, the entire plot was fertilized with ammonium nitrate and blended phosphate at the rate of 100 pounds of available nitrogen per acre and 50 pounds of available phosphorus per acre. The plot was broadcast seeded (the species list is contained in the July 1984 CB Data Report) and was then mulched with a netted fiber matting. This type of mulch was used in an attempt to reduce the number of weedy annual species which tend to dominate revegetated areas during the first and second years at the CB site. After the mulch was placed on the plot, nursery stock transplants were planted on each of the six different treatments. The transplanted species included serviceberry (Amelanchier alnifolia), mountain mahogany (Cercocarpus montanus), antelope bitterbrush (Purshia tridentata), Wood's rose (Rosa woodsii), mountain snowberry (Symphoricarpos oreophilus), and pinyon pine (Pinus edulis). The plot was irrigated using a sprinkler nozzle on a hydromulcher, saturating the plot to the extent that some leachate was collected. The purpose of irrigating the plot was to simulate winter precipitation. During the 1983 growing season, 8.25 inches of irrigation water were applied on the test plot. A total of 7 inches was applied prior to the time of sampling. In May 1984 the test plot was fertilized at the rate of 100 pounds of available nitrogen and 100 pounds of available phosphorus per acre. After application of the fertilizer, the plot was sprinkler irrigated with approximately one inch of water. The plot was irrigated again in July with approximately 0.5 inches of water. Total supplemental water applied in 1984 was approximately 1.5 inches. The test plot was fenced to prevent grazing by domestic livestock.

Field sampling methods were the same as those used in the raw shale demonstration test plot. Cover and production were estimated in twenty 0.1 m^2 quadrats for each treatment. Clipped samples were obtained from four of the production plots in each of the six treatments.

The production data were evaluated using a two-way analysis of variance which tests the hypotheses that no significant differences occur as a result of topsoil depth or introduction of sewage sludge. It also evaluates whether the interaction of sewage sludge and topsoil thickness is significant.

Soil samples were taken in the fall (October) following the growing season. The soil sampling was conducted on the two treatments consisting of 12 inches of topsoil over processed shale and the 12 inches of topsoil over the sewage-sludge-treated processed shale. The soil samples were composite samples taken at three different depth intervals: 0-6 inches, 6-12 inches, and 12-20 inches. The samples were taken with a 2-inch diameter soil auger. The composite samples consisted of combining and mixing three individual samples of each depth interval from each of the two treatments. This sampling was conducted in 1983 as well as 1984. As a part of the 1983 sampling, an additional composite soil sample was also taken from the stockpiled topsoil used to cover the plot for use as a control. The stockpiled topsoil was not sampled again in 1984. The samples were sent to a soils lab for analysis. The parameters included in the analysis were: pH, ECe, CEC, SAR, NO_3, NH_3, K, B, Na, Mo, and Cu. The results of the 1983 analysis were discussed in last year's report. This report will discuss the results of the 1984 sampling and analysis and compare those results with 1983 results.

On the plots treated with sewage sludge, mean total herbaceous cover was quite comparable among the three topsoil treatments. Mean total cover ranged from 60.0 percent on the 18-inch topsoil treatment to 44.0 percent on the 6-inch topsoil treatment. Mean cover on the 12-inch topsoil treatment was 54.9 percent. In 1983 the total herbaceous cover values were slightly higher, and the values were not directly related to the topsoil depths. In 1983 the highest mean cover value was from the 12-inch treatment followed by the 6-inch and 18-inch treatments. The major species on all three treatments was smooth brome (Bromus inermis) with mean cover values of 35.2, 48.9, and 54.9 percent on the 6-, 12-, and 18-inch treatments respectively. Russian wildrye occurred as a secondary dominant. The wheatgrass species accounted for less than 5 percent of the total cover. Weedy species comprised only a minor part of the total cover. On the plots not treated with sewage sludge, mean total cover was quite comparable with values that ranged from 77.0 percent on the 18-inch treatment to 66.8 on the

6-inch treatment. Mean cover on the 12-inch treatment was 72.2 percent. As with the sewage sludge treatments, most of the cover was provided by smooth brome and Russion wildrye. Mean total herb cover was approximately 20 percent higher in 1984 compared with 1983, and there was a direct relationship between topsoil depth and the amount of total cover.

In all treatments, most of the biomass was contributed by the smooth brome and other perennial grasses. Smooth brome was the overwhelming dominant in each of the treatment blocks. In the treatments with sewage sludge, mean total production was highest in the 18-inch treatment (394.2 g/m^2, followed by the 12-inch treatment (291.6 g/m^2) and the 6-inch treatment (223.6 g/m^2). (These weights convert to 3527 lbs/ac, 2602 lbs/ac, and 1995 lbs/ac, respectively.) The mean production values increase with increasing topsoil depth. In the treatments without sewage sludge, mean total production was highest in the 18-inch treatment (239.1 g/m^2) followed by the 12-inch treatment (184.1 g/m^2) and the 6-inch treatment (136.6 g/m^2). (These weights convert to 2133 lbs/ac, 1643 lbs/ac, and 1219 lbs/ac. respectively.) In these treatments, mean production also follows the topsoil gradient. In all cases the treatments with sewage sludge had higher production than their corresponding treatments without sewage sludge. The significance of the differences among the different treatments was tested using a two-way analysis of variance. The results of the analysis (Table 9-14) show that the differences attributable to the sludge application were significant, and the differences attributable to topsoil thickness were also significant. The interaction of topsoil thickness and sewage sludge application was not significant. These results suggest that total production can be significantly increased by the application of sewage sludge and by increasing the depth of respread topsoil. The results of the two-way analysis and the conclusions are the same as those reached in 1983, except that the differences were more pronounced in 1984. While these conclusions should be considered to be tentative, it appears that the differences related to topsoil depth and application of sewage sludge are real and may be very important relative to full-scale revegetation of processed shale disposal areas. It will be important to evaluate the treatments in subsequent years to see if the relationships noted in 1983 and 1984 are consistent from year to year. Also, trends during subsequent years in species composition with only maintenance fertilization will be interesting.

TABLE 9-14 Results of the Two-Way Analysis of Variance Test for Evaluating the Effects of Sewage Sludge Application and Topsoil Thickness on the Processed Shale Demonstration Plot. 1984 Data.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F	Significance
Subgroups					
A (Sludge)	1	4095.77	4095.77	81.697	SIG
B (Topsoil Thickness)	2	3763.97	1881.98	37.539	SIG
Interactions					
A x B (Sludge x Topsoil Thickness)	2	248.06	124.003	2.474	NS
Within (Error)	114	5715.26	50.13		
Total	119	13,823.06			

SIG = Significant

NS = Not Significant

$F_{0.05[1,14]} = 3.93$ $F_{0.05[2,14]} = 3.08$

The following discussion concerns the results of the 1984 soils analysis. The individual soil parameters are discussed separately.

Hydrogen Ion Concentration (pH). The pH readings observed in 1984 were lower for each of the depth intervals in both treatments than were observed in 1983. The highest reading observed in 1984 was 7.6, in the 12-20 inch interval for the topsoil-cover plus sewage-sludge treatment. The lowest reading was 7.2, which was the reading for the top 12 inches in both treatments. These readings compare very favorably to the 1983 topsoil control sample which was 7.5. The optimal range for plant growth is from 6.0-9.0. Therefore, the pH of the top 20 inches of the plot should not be a future concern for plant growth.

Electrical Conductivity (ECe). Values are expressed as mmhos/cm. This is used to test the levels of soluble salts. As was the case with pH, ECe levels were lower in 1984 than 1983. The levels in the top 12 inches, for both treatments, were less than 1.0. Richards (1954) reported that levels less than 2.0 mmhos/cm should have negligible effects on salt sensitive plants. The vegetation species which CB uses for processed shale reclamation have moderate to high salt tolerances; therefore, the optimal range for plant growth for the species planted would be less than 4.0. ECe values in the top 12 inches are not of concern. However, the levels for the 12-20 inch depth was 7.0 for the soil-cover-only treatment and 8.4 for the soil-cover plus sewage-sludge treatment. Even though these levels are higher than the optimal range, they have decreased significantly since the 1983 sampling (down from 20.0 and 13.0, respectively). This is encouraging since it appears that salts are being leached to lower levels in the soil profile. This parameter will be checked in subsequent years to assure that salts are indeed being leached out of the active rooting zone.

Cation Exchange Capacity (CEC). This is a measure of number of negative charges per unit quantity of soil neutralized by easily replaceable cations. The CEC of the sample is expressed as milliequivalents per 100 grams of soil. Generally speaking the higher the CEC the more fertile the soil (i.e., organic matter has a higher CEC than clay soils). The 1984 CEC levels have increased since the 1983 sampling. Soils with CEC levels greater than 10-15 meq/100g are considered adequate for plant growth. The 1984 levels are greater than this range.

Sodium Absorption Ratio (SAR). The SAR's of all samples in 1984 were less than the respective 1983 samples. The optimum range for plant growth is less than 10%. All 1984 samples, with exception of the 12-20 inch depth of the soil-cover-plus-sewage-sludge treatment which was 19%, are below this level.

Sodium (Na). Plants which have moderate to high salt tolerances should not be affected by sodium concentrations which are less than 2300 ppm. All 1984 samples had concentrations less than 2300 ppm. Also, the sodium concentrations have decreased since 1983.

Boron (B). The concentrations of boron in the soil samples do not appear to be a problem since the 1984 observed concentrations are equal to or less than 2.0 ppm, which is the concentration at which plants sensitive to boron begin to show toxicity symptoms.

Calcium (Ca) and Magnesium (Mg). It is desirable to have higher calcium concentrations than magnesium concentrations in soils used as plant growth mediums. The soil samples from the demonstration plot have had concentrations of calcium which are greater than those of magnesium.

Molybdenum (Mo) and Copper (Cu). The 1984 sample concentrations of Mo and Cu are within the range of native soils on Tract C-b. These concentrations do not appear to be limiting or toxic. Most problems encountered with these two elements result when the ratio of Cu to Mo is less than 2:1. This is not the case for the soil samples from the demonstration plot.

Nitrogen (NO_3 and NH_4), Phosphorus (PO_4), and Potassium (K). These three elements are recognized as the primary plant food nutrients and are those mostly associated with fertilization. The results from the past two years of analysis indicate that sewage sludge may have positive effects on the availability of both N and P. The concentrations of these elements were greater for both years of sampling in the sewage sludge treatment than the soil-cover-only treatment. Nitrogen is an element that is soluble in soils, while phosphorus is more stable and is released in available form at a slower rate. It appears that CB's fertilization efforts over the last two years have had positive effects. The 1984 concentrations of P in the upper 20 inches of both treatments should be

adequate for plant growth. The observed concentrations of N (with the exception of the 12-20 inch depth of the sewage sludge treatment) and K indicate a need to fertilize the plot with these elements in the following year(s).

The amount of herbaceous production and cover of the demonstration plot indicates that the growth medium is adequate for plant growth. The soils analysis from the past two years confirms this observation. The differences in the soils analysis between the first and second years indicate that the soil (at least the upper 20 inches) is improving over time as a plant growth medium. It will be important to continue evaluation of the soils to see if the trend toward a better growth medium is maintained during subsequent years.

9.3.10.2.2 <u>1984 Processed Shale Demonstration Plot</u>

A second processed shale revegetation demonstration plot was constructed in August 1984 at the C-b Tract. This demonstration plot consists of three subplots, or treatments. These include:

1) 1 foot of topsoil over uncompacted (loosely dumped) Union B processed shale;
2) 1 foot of topsoil over a layer of uncompacted Union B processed shale underlain by a layer of wetted and compacted Union B processed shale; and
3) 1 foot of topsoil over wetted, uncompacted Lurgi processed shale.

All three treatments are double-lined with a reinforced plastic liner and a double bonded poly-plastic liner. The treatments are sloped to a central point where leachate will drain into a funnel, and tubing to be collected outside the treatments by a collection system consisting of a series of polyethylene bottles. See Figures 9-24 to 9-27 for more detail.

The objectives of the demonstration plot are to:

1) Test the proposed CB species seed mixture (see Table 9-15);
2) Demonstrate the reclamation success of CB's proposal to use one foot of topsoil over retorted shale;
3) Field test CB's proposal of using a heavily compacted zone of Union B

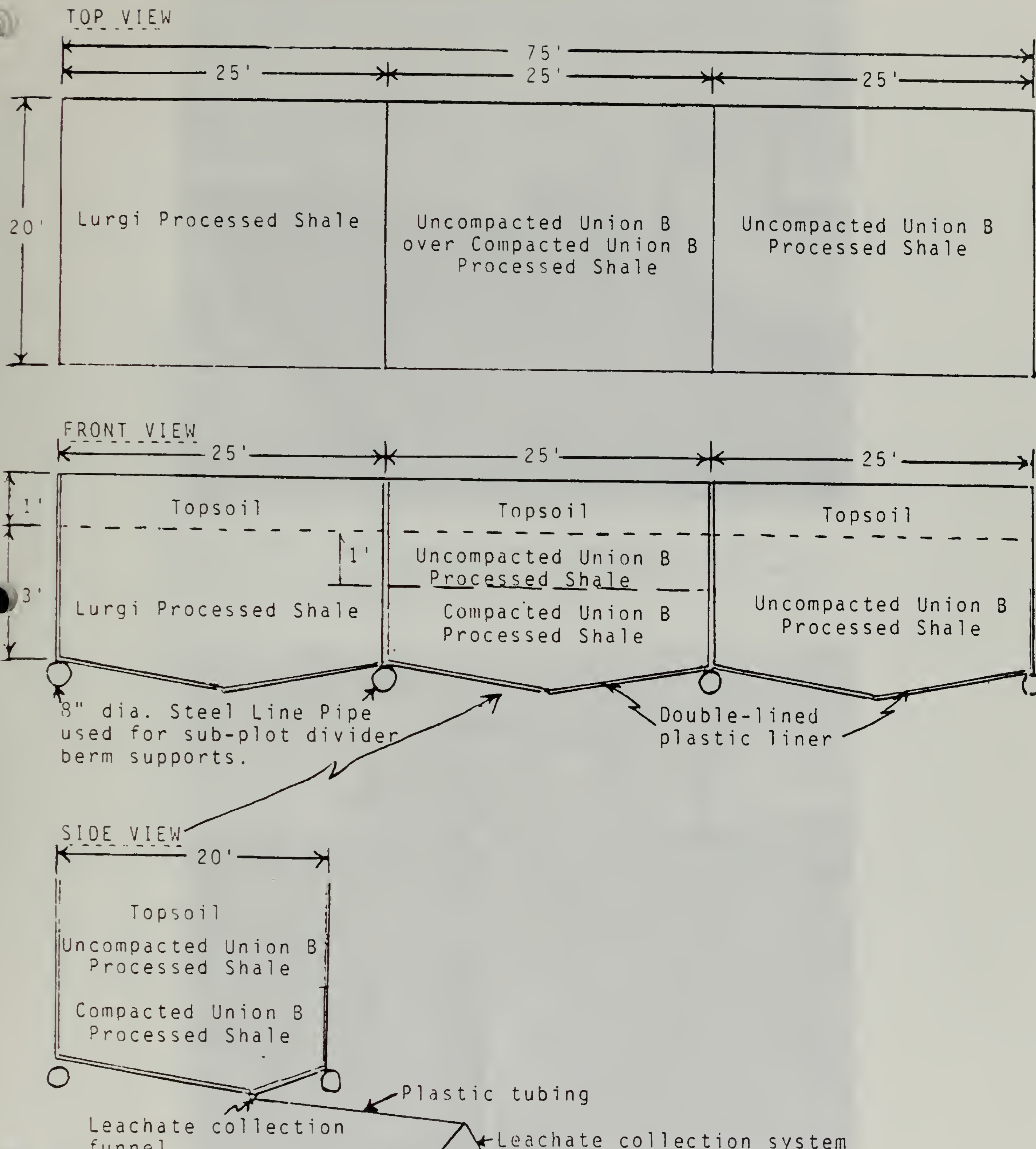


FIGURE 9-24 CB 1984 Revegetation Demonstration Plot.

FIGURE 9-25 1984 Processed Shale Demonstruction Plot:
Lurgi Shale (Bottom); Compacted Union (Middle);
Uncompacted Union (Top)

FIGURE 9-26 1984 Close-Up - Processed Union Shale
Compacted (Right); Uncompacted (Left)

FIGURE 9-27 Putting Topsoil on the Processed Shale Demonstration Plot

TABLE 9-15

Species Mixture for Retorted Shale Disposal Pile Reclamation

Species		Seeding Rate lbs/Acre Drilled
*Grasses:		
Agropyron cristatum (Fairway)	- crested wheatgrass	1/2
Agropyron elongatum (Jose)	- tall wheatgrass	1/2
Agropyron intermedium (Amur)	- intermediate wheatgrass	1/2
Agropyron smithii (Arriba)	- western wheatgrass	1
Agropyron trichophorum (Luna)	- pubescent wheatgrass	1/2
Bromus inermis (Manchar)	- smooth brome	1/4
Elymus cinereus (Magnar)	- great basin wildrye	1
Elymus junceus (Vinal)	- Russian wildrye	1
Festuca ovina (Durar)	- hard fescue	1/4
Sporobolus airoides	- alkali sacaton	1/8
Sporobolus cryptandus	- sand dropseed	1/8
*Forbs:		
Astragalus cicer (Lutana)	- cicer milkvetch	1/2
Hedysarum boreale	- Utah sweetvetch	1
Linum lewisii	- Lewis flax	1/4
Medicago sativa (Ranger or Ladak)	- alfalfa	1/2
Penstemon palmeri	- Palmer's penstemon	1/4
Sphaeralcea coccinea	- globemallow	1/4
*Shrubs:		
Artemisia tridentata	- big sagebrush	1/2
Atriplex canescens (Rincon)	- four wing saltbush	1-1/2
Purshia tridentata (Maybelle)	- antelope bitterbrush	1
	TOTAL	13-1/4 lbs/ac

* Seed (P.L.S. - pure live seed)

retorted shale as a "cap" to reduce the rate of water movement into and through the disposal pile;

4) Demonstrate reclamation success of a retorting process which would utilize raw shale fines (this type of retorted shale would be expected to have similar properties to the Lurgi processed shale);
5) Measure water movement and water holding capacity of the different layers and materials. Each treatment has incorporated two aluminum tubes. These serve as access tubes for a neutron hydroprobe for soil moisture determination.
6) Collect and sample leachate quantity and quality;
7) Demonstrate CB's proposal of using only minimal amounts of irrigation to provide for vegetation establishment during the first and second growing season;
8) Demonstrate the use and need of fertilizers as a growth medium amendment.

All treatments were seeded in the fall with the proposed species mixture for retorted shale disposal pile reclamation (Table 9-15). Each treatment will be sprinkle-irrigated during the 1985 growing season on an as-needed basis (visual observation and hydroprobe readings will be used to determine when irrigation is needed). Total amount of irrigation will be approximately 6 to 8 inches.

Phosphate and potassium fertilizer was incorporated into the top layer of retorted shale prior to covering with topsoil at the rate of 400 and 80 pounds per acre respectively. N-P-K fertilizer will be applied on the surface in the spring of 1985 at the rate of 80-100-50 pounds per acre.

Sampling for revegetation success will be initiated during the 1985 growing season. Sampling methodology and data analysis will be consistent with types used on the other CB demonstration plots. Soil sampling and analysis will be conducted during 1985. Leachate will be collected on an as-needed basis during the year. Quantity and quality will be sampled for all three treatments.

9.3.10.3 Topsoil Stockpiles

The same four topsoil stockpiles which were sampled in 1983 were sampled again in 1984. The stockpiles were sampled for species composition, vegetative

cover, herbaceous production, shrub cover and shrub density. The sampling methods used were consistent with those used for other vegetation monitoring studies in past years.

Two of the topsoil embankments were seeded in the fall of 1978. The topsoil in these embankments came from the Mine and Support Facilities areas. These embankments were seeded, straw mulched, and fenced in the fall of 1978. The species seeded and the rates of seeding are listed in the July 1984 Data Report. Seeding was completed with a rangeland drill. These embankments are labeled as the northwest stockpile and the southernmost stockpile.

The other two embankments were seeded in the fall of 1980. The topsoil came from the area where the raw shale stockpile is presently located. These embankments were seeded with a rangeland drill (species and rates of seeding are listed in the July 1984 Data Report), hydromulched, and fenced in the fall of 1980. These embankments have been labeled as the E/S shed stockpile and the fabrication shop stockpile.

The objectives of sampling these embankments are twofold: 1) to demonstrate the revegetation potential of disturbed sites, and 2) determine the effects of cattle grazing on revegetated sites relative to species composition and production.

Herbaceous production, plant cover, species diversity (number of species per meter squared), and shrub density are being evaluated on the grazed vs. ungrazed piles. The piles which were planted the same year with the same seed mixture are being compared (i.e., northwest pile vs. southernmost pile and Fab shop pile vs. E/S shed pile). The null hypothesis which is being tested is that no significant difference exists in the means of the paired piles. The parameters are also being evaluated for the same pile from one year to the next. For these comparisons, herbaceous production is tested using the standard Student's t-test. The null hypothesis being tested is that there is no significant difference in the means from year to year for any given pile. Cover, diversity, and shrub density, which are sampled at the same permanently located quadrats and transects from year-to-year, are being tested using a paired t-test. The null hypothesis being

tested is that the mean difference from one year to the next, for any given pile, is equal to zero. The results of the tests are shown on Tables 9-16 and -17.

The estimated total herbaceous cover for the northwest pile (no grazing) was 58.8 percent with mean number of species per square meter of 5.35. Mean shrub cover was 0.08 percent with an estimated density of 415 individuals per hectare. The mean total herbaceous production was 208.7 grams/m^2 (1862 lbs/acre) dry weight. This is three times the amount of production which was found in the range cages in the chained rangeland vegetation type. Most of the herbaceous cover and production was attributed to the wheatgrasses. Cicer milkvetch was the dominant forb. The majority of the shrub species ranged from 0.26-0.75 meters in height.

The southernmost pile (grazed) had a herbaceous cover value of 51.5 percent with 5.2 species/m^2. Shrub cover was estimated at 0.9 percent with an estimate of 801 individuals per hectare. Herbaceous production was estimated at 183.6 grams/m^2 (1638 lbs/acre). The dominant species were the same as above.

The Environmental Services' shed pile (grazed) had a herbaceous cover value of 62.9 percent with 7.65 species/m^2. Shrub cover was 0.02 percent with 951 individuals per acre. The majority of shrubs were less than 0.25 meters in height. Total herbaceous production was 190.1 grams/m^2 (1696 lbs/acre). The major species were the wheatgrasses and alfalfa.

The fab shop pile (no grazing) had a herbaceous cover value of 67.65 percent with a mean number of species per m^2 of 8.65. Shrub cover was less than 0.01 percent with an estimate of 253 individuals per acre. Total herbaceous production was 229.6 grams/m^2 (2049 lbs/acre). The major species are the same as above.

<u>Herbaceous Production</u>. As was stated previously, the topsoil stockpiles are paired, for comparison purposes, based on year planted and seed mixture used. The 1983 production estimates for the paired piles were evaluated using a one-way analysis of variance and were found to be not significant. The 1984 production estimates were also evaluated using the same test. The differences in production of stockpiles seeded in 1978 were found to be not significant. However, the

TABLE 9-16 One-Way Analysis of Variance Results for Comparisons of Differences among Paired-Piles (Grazed vs. Ungrazed Piles Which Were Seeded the Same Year) for Herbaceous Production, Plant Cover, Species Diversity, and Shrub Density. 1983 and 1984 Data.

	Calculated F	Critical Region* (F>)	Significance**
DIFFERENCES IN SPECIES DIVERISTY (# of species/m^2) - 1983			
Northwest pile vs. Southern pile	1.331	4.1020	NS
Fab Shop pile vs. E/S Shed pile	12.3685	4.1020	Sig
DIFFERENCES IN SPECIES DIVERSITY (# of species/m^2) - 1984			
Northwest pile (ungrazed) vs. Southern pile (grazed)	0.0824	4.1020	NS
Fab Shop pile (ungrazed) vs. E/S Shed pile (grazed)	3.245	4.1020	NS
DIFFERENCES IN SHRUB DENSITY (# of shrubs/40m^2) - 1983			
Northwest pile vs. Southern pile	8.428	4.1020	Sig
Fab Shop pile vs. E/S Shed pile	5.788	4.1020	Sig
DIFFERENCES IN SHRUB DENSITY (# of shrubs/40m^2) - 1984			
Northwest pile (ungrazed) vs. Southern pile (grazed)	4.239	4.1020	Sig
Fab Shop pile (ungrazed) vs. E/S Shed pile (grazed)	12.4444	4.1020	Sig

* The critical region was set at the 0.05 level of significance with 1 and 38 degrees of freedom ($F > F_{0.05[1,38]}$).

**NS = no significant difference
Sig = significant difference

TABLE 9-16 (Continued) One-Way Analysis of Variance Results for Comparisons of Differences Among Paired-Piles (Grazed vs. Ungrazed Piles Which Were Seeded the Same Year) for Herbaceous Production, Plant Cover, Species Diversity, and Shrub Density. 1983 and 1984 Data.

	Calculated F	Critical Region* (F>)	Significance**
DIFFERENCES IN SPECIES DIVERISTY (# of species/m^2) - 1983			
Northwest pile vs. Southern pile	1.331	4.1020	NS
Fab Shop pile vs. E/S Shed pile	12.3685	4.1020	Sig
DIFFERENCES IN SPECIES DIVERSITY (# of species/m^2) - 1984			
Northwest pile (ungrazed) vs. Southern pile (grazed)	0.0824	4.1020	NS
Fab Shop pile (ungrazed) vs. E/S Shed pile (grazed)	3.245	4.1020	NS
DIFFERENCES IN SHRUB DENSITY (# of shrubs/40m^2) - 1983			
Northwest pile vs. Southern pile	8.428	4.1020	Sig
Fab Shop pile vs. E/S Shed pile	5.788	4.1020	Sig
DIFFERENCES IN SHRUB DENSITY (# of shrubs/40m^2) - 1984			
Northwest pile (ungrazed) vs. Southern pile (grazed)	4.239	4.1020	Sig
Fab Shop pile (ungrazed) vs. E/S Shed pile (grazed)	12.4444	4.1020	Sig

* The critical region was set at the 0.05 level of significance with 1 and 38 degrees of freedom ($F > F_{0.05[1,38]}$).

**NS = no significant difference
Sig = significant difference

[illegible]

TABLE 9-17 Estimated Means for Herbaceous Production, Plant Cover, Species Diversity, and Shrub Density for the Topsoil Stockpiles. 1983 and 1984 Data.

Topsoil Stockpile	Herbaceous Production[1] (g/m^2)			Plant Cover[2] (%)			Species Diversity[2] (spp/m^2)			Shrub Density[2] ($\#/40m^2$)		
	1983		1984	1983		1984	1983		1984	1983		1984
Northwest Stockpile - seeded in 1978, and ungrazed in 1984.	232.12	-	208.67	30.35	a	58.80	5.65	-	5.35	1.65	-	1.65
Southern Stockpile - seeded in 1978, and grazed in 1984.	247.98	a	183.60	40.60	a	51.50	5.10	-	5.20	4.20	a	3.35
Fab Shop Stockpile - seeded in 1980, and ungrazed in 1984.	252.46	-	229.63	47.95	a	67.65	8.55	-	8.65	2.25	a	1.05
E/S Shed Stockpile - seeded in 1980, and grazed in 1984.	221.12	a	190.09	36.85	a	62.90	6.70	-	7.65	4.30	-	3.85

1 Herbaceous production was tested using the Student's t-test with $\alpha = 0.10$.

2 Plant cover, species diversity, and shrub density were tested using paired t-test with $\alpha = 0.10$.

3 Values having "a" between them are significantly different.

differences in production of the piles seeded in 1980 were significant with the production of the grazed pile being less than that of the ungrazed pile.

In 1984 production estimates were less on all four stockpiles than were measured in 1983. However, only the grazed stockpiles were significantly different in 1984.

Plant Cover. The plant cover estimates for the stockpiles were evaluated using the same tests and levels of significance as were used for herbaceous production. The paired pile comparisons found the estimated values to be not significantly different in 1984. However, in 1983 prior to grazing, the paired piles were significantly different. When the 1984 estimates were compared to the 1983 estimates using a paired t-test all differences were significant. The 1984 estimates were greater on all four stockpiles.

It is suspected that the increases in herbaceous cover estimates from 1983 to 1984 are more the result of estimating technique rather than actual changes in plant cover. Even though the use of permanent quadrats reduces sampling error, by eliminating the variability caused by sample quadrat location, it is very difficult to be totally consistent from year to year when visually estimating species cover.

Species Diversity. Species diversity is determined by the number of species observed per each square meter quadrat. The diversities for the paired pile comparisons were evaluated using a one-way analysis of variance and were found to be not significant, except for the Fab shop pile vs. the E/S shed pile in 1983. The Fab shop pile had a greater number of species sampled per square meter.

The differences in species diversity from year to year for any particular stockpile are being evaluated through the use of a paired t-test. These evaluations resulted in no significant differences existing between the 1983 and 1984 data for all four stockpiles.

Shrub Density. The paired pile comparisons for shrub densities were found to be significantly different in both 1983 and 1984. The two grazed piles (the southernmost and the E/S shed piles), in both comparisons and years, had a significantly higher number of individuals encountered during sampling.

The yearly differences in shrub densities are also being evaluated through the use of a paired t-test. This evaluation resulted in findings of no significant differences in density from 1983 to 1984 for the northwest stockpile (ungrazed pile seeded in 1978) and the E/S shed stockpile (grazed pile seeded in 1980). The differences from 1983 to 1984 for the other two piles were significantly different (the number of individuals being greater in 1983 for both piles.

9.3.11 Special Projects

9.3.11.1 Sprinkler-Irrigation System Impacts

The sprinkler-irrigation system which was used to dispose of excess mine water during the growing seasons of 1980 and 1981 has not been used since the late summer of 1981. However, the concentration and build-up of salts and specific ions in soils and vegetation from the water applied during the two seasons of operation does not necessarily disappear once irrigation ceases. Therefore, a chemical analysis of the soils and vegetation was conducted in 1982 to determine the concentration levels of salts and ions in the soils and vegetation one year following irrigation. The results of the 1982 analysis concluded that the concentrations of parameters in the soil and vegetation were, for the most part, significantly below toxic concentrations and were not considered to be of concern. However, since there were slight increases in some parameters observed in 1982 it was decided to do a limited amount of sampling and analysis in 1983.

The 1983 sampling was limited to areas designated as treatment 5b and the Control Area. Treatment area 5b was chosen because it received the same amounts of irrigation, the same duration of irrigation, and the same repetitions of irrigation as the entire irrigated areas.

Results of 1983 sampling and analysis indicated that the concentrations of all parameters tested for both the soils and vegetation were significantly less than toxic levels and, with the exception of sodium, 1983 levels were no different, or less than 1982 levels. Sodium concentrations in the vegetation were significantly higher in 1983 than in previous years. No apparent reason was

known for the high sodium concentrations. Since all the individual samples showed high concentrations it was likely a result of natural conditions; however, it is possible that something occurred in sampling or the laboratory analysis that caused the high concentrations. In any event, CB personnel collected vegetation samples in October 1984 which were analyzed for sodium.

The species of vegetation sampled were again Agropyron smithii (western wheatgrass) and Artemisia tridentata (big sagebrush). Four replicate samples of these two species were collected from treatments 5b and the Control Area. Results of the analysis are presented in the January 1985 CB Data Report.

The observed levels for 1984 are significantly less than 1983 levels (see Table 9-18). In fact, the 1984 levels reduced to near 1982 levels. This would suggest that the 1980 and 1981 sprinkler-irrigation system has not had any lasting effects on the vegetation. (This same conclusion was reached for soils last year.) Therefore, CB proposes to discontinue any future sampling in this area, unless irrigation is used again.

9.3.11.2 1979 Sagebrush Beating Project - Vegetation

Two sagebrush dominated gulches (Gardenhire and Oldland), north of C-b Tract, were brush beaten in 1979. This action was conducted as a mitigation project having the following objectives: (1) improve forage for wildlife and livestock, (2) reduce deer winter range use by livestock and (3) reduce the number of deer roadkills in early spring.

Vegetation and wildlife studies were initiated in 1980. Vegetation studies included yearly monitoring of species composition and herbaceous production. Yearly vegetation sampling was discontinued following 1982 (three years following treatment), with the intent of sampling every third or fourth year in order to establish trends in the plant community and to estimate the effective life of the brush treating treatment.

The results of the 1980-1982 studies have been discussed in past years reports, and therefore will not be discussed again here. Vegetation studies were not scheduled to be conducted in 1983 and 1984; however, since both these years

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE 9-18 The Mean Concentrations (ppm) of Sodium (Na) in Foliage of *Agropyron smithii* and *Artemisia tridentata* at the End of Growing Seasons 1980 - 1984. Vegetation samples taken from areas designated as treatments 5b and Control for the 1980 and 1981 Irrigation Area.

Species	Treatment#	1980	1981	1982	1983	1984[a]
Agropyron smithii	5b	455.1	354.4	258.0	738	97.0
	Control	--	212.8	127.6	780	97.7
Artemisia tridentata	5b	663.5	214.7	132.0	1036	247.5
	Control	--	57.9	157.0	1014	164.0

[a] 1984 concentrations were compared to 1983 concentrations, and both treatment areas and species values were significantly less than 1983 values. 1984 values were also significantly less than toxic concentrations. Values were evaluated using a t-test with $\alpha = 0.05$.

received higher than normal precipitation it was decided to do a limited amount of herbaceous productivity sampling in one of the gulches (Gardenhire) and part of the control area.

This limited amount of sampling estimated herbaceous production in Gardenhire Gulch to be approximately 1500 lbs/ac (dry weight) and approximately 550 lbs/ac in the control area. These estimtes compare to 1982 estimates of 612 lbs/ac in Gardenhire and 340 lbs/ac in the control area. (The 1982 estimates were the highest estimates of the previous three years of sampling.)

9.3.11.3 Reseeding the Burn Area

In September, 1983 a small wildfire burned approximately 10 acres of pinyon-juniper woodlands on BLM land north of the Piceance Creek road. (This burn area is just northeast of Tract C-b and is located in T2S, R96W, Section 28.) CB received permission from the BLM to conduct an experimental seeding in the burn area. If the seeding proved successful, this action could be considered as a mitigation project, and similar actions of burning and reseeding (particularly in the chained areas) could be considered for future mitigation projects.

The burn was divided into 10 areas. Five areas (approximately 5 acres, or half the burn area) were broadcast seeded with the seed mixture listed in Table 9-19. This seed mixture is composed of species used in reclamation activities on Tract C-b. The other five areas, which were similar in slope and aspect, were not seeded and were set-up as control areas.

The burn area was visited by CB personnel in August 1984. A visual observation of the area concluded that the seeding had not yet had any effect on the burn area. The vegetation that was growing in the burn area was comprised mostly of *Stipa comata* (needle and thread grass), which is the major grass in the understory of the surrounding unburned area, and annual weeds. It is possible that the seeded species will not germinate and/or begin to appear in abundance in the plant community until later years. Therefore, CB personnel will again visit the site during the 1985 growing season.

TABLE 9-19 Species Mixture for Wildfire Burn Area.

SPECIES	Lbs/Acre
Grasses:	
Agropyron cristatum - crested wheatgrass	1
A. smithii (rosana) - western wheatgrass	2
A. intermedium (amur) - intermediate wheatgrass	2
Bromus inermis - smooth brome	1
Elymus cinereus - Great basin wildrye	1
E. junceus - Russian wildrye	1
Forbs:	
Astragalus cicer - cicer milkvetch	1/2
Hedysarum boreale (Utah) - Utah sweetvetch	1/2
Medicago sativa - alfalfa	1/2
Penstemon sp. - penstemon	1/2
Linum lewisii - Lewis flax	1/4
Shrubs:	
Artemisia tridentata - big sagebrush	1/2
Atriplex canescens - four wing saltbush	2
Cercocarpus montanus - mountain mahogany	1
Cowania mexicana - stansberry cliffrose	1
Eurotia lanata - winterfat	1
Purshia tridentata - bitterbrush	1
TOTAL	16-3/4

9.3.12 Ecosystem Interrelationships

No studies in this area were conducted in 1984 other than those noted under Special Projects, Section 9.3.11.

9.3.13 Items of Aesthetic, Historic, or Scientific Interest

Surface activity was limited in 1984 so that minimum impact on aethetics occurred. Good "housekeeping" is monitored by regular site inspections by the OSPO and by consistent alertness of the environmental on-site staff.

9.3.14 Health and Safety

Accident frequency analyses are included in the semi-annual data reports to the OSPO. At C-b, based on 46,659 man-hours, there were four lost-time accidents. The site injury (incident) rate in 1984 was 17.15 (reportable accidents x 200,000/man-hours ÷ hours of employee exposure). This compared with two lost-time accidents in 1983, and an injury rate of 2.56. A plan is underway to reduce this accident rate through training, job safety analysis and conduct of frequent safety meetings.

9.3.15 Toxicology

Toxicological testing has been curtailed due to reduced on-site activity. A continuation of the toxicological program is being planned for the future.

9.3.16 Data Management and Quality Assurance

Air data are incorporated in a computerized data base management system called RAMIS. The basic data report generated is a diurnal table of hourly-average values for each variable, excepting particulates which are measured every fourth day as a daily total. Monthly air reports are generated and incorporated in six-month data reports along with summary tables and graphs. Hourly values are also stored on a tape supplied to the OSPO; see Table 9-20.

Regarding quality assurance for air data, daily zero-and span-checks are made to check for potental drifts. Monthly multipoint calibrations are made for

TABLE 9-20

Status of the Automated Environmental Data Base

HYDROLOGY AND WATER QUALITY	
Water Quality	
Springs and Seeps	October 1974 thru November 1981
Alluvial Wells	October 1974 thru November 1981
Deep Bedrock Wells	October 1974 thru November 1983
Field Measurements	
Springs and Seeps	October 1974 thru February 1985
Alluvial Wells	October 1974 thru November 1981
Deep Bedrock Wells	October 1974 thru February 1985
Levels and Flows	
Well Levels	October 1974 thru February 1985
Spring Flows	October 1974 thru February 1985
Water Augmentation Plan	
Springs and Seeps	July 1979 thru January 1985
Deep Bedrock Wells	August 1979 thru January 1985
Precipitation	January 1979 thru December 1984
National Pollutant Discharge Elimination System	
Water Quality Data	July 1979 thru February 1985
Water Usage	June 1980 thru February 1985
Well Reinjection	March 1981 thru June 1982 (Discontinued)
Surface Stream Flows/WQ	June 1982 thru June 1984
AIR QUALITY	
Air Quality Trailer AB23	October 1974 thru February 1985
Trailer AB20	October 1974 thru January 1982
Trailer AB26	October 1981 thru March 1982
Meteorological Tower AA23	October 1974 thru February 1985
Weather Station AD20	February 1982 thru July 1982
Station AD42	October 1974 thru March 1982
Station AD56	October 1974 thru August 1980
VISIBILITY	
Telephotometric	September 1975 thru October 1984
Photographic (Discontinued)	September 1975 thru October 1982
Traffic	February 1980 thru February 1985
Biology	
Microclimate	October 1974 thru March 1985
Deer Kill	October 1977 thru January 1985
Deer Count	September 1977 thru January 1985
Avifauna	1977 thru 1981

all gaseous data. Third party quarterly audits (see discussion in Section 9.3.5) and data precision checks (see most recent data report) are part of the quality assurance program.

Water data are also incorporated in RAMIS, excepting streams data which are stored in the USGS WATSTOR data base and interrogated by the Project's computer dial-up. Values are then incorporated into the 6-month data reports to the OSPO and put on tapes as indicated in Table 9-20.

Split and spiked samplings are utilized on a fraction of the samples to enhance quality of the water data.

9.3.17 Reporting

Annual reports are submitted to the OSPO during the anniversary month of the Lease (April). Semi-annual Data Reports are submitted on January 31 and July 31. Air quality data volumes in these reports are also submitted to EPA, Region VIII, and the Air Quality Control Division of the Colorado Department of Health. Hydrologic data have been forwarded to the USGS in Denver to provide additional inputs for the regional groundwater modeling development.

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Quarterly Data Report #5	January 15, 1976
Quarterly Data Report #6	April 15, 1976
Quarterly Data Report #7	July 15, 1976
Quarterly Data Report #8	October 15, 1976
Quarterly Data Report #9	January 15, 1977
Interim Monitoring Report	October 17, 1977
Interim Monitoring Report, Supplemental	December 16, 1977
Interim Monitoring Report	May 15, 1978
Development Monitoring Report #1	January 15, 1979
Development Monitoring Report #2	July 15, 1979
Development Monitoring Report #3	January 15, 1980

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CB Shale Oil Project: Data Reports (Continued)

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Development Monitoring Report #5	January 15, 1981
Development Monitoring Report #6	July 15, 1981
Development Monitoring Report #7	January 15, 1982
Environmental Monitoring Report	July 15, 1982
Environmental Monitoring Report	January 15, 1983
Environmental Monitoring Report	July 15, 1983
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Environmental Monitoring Report	July 15, 1984
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Summary Report #5, (thru November 30, 1975)
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Summary Report #8, (thru August 31, 1976)

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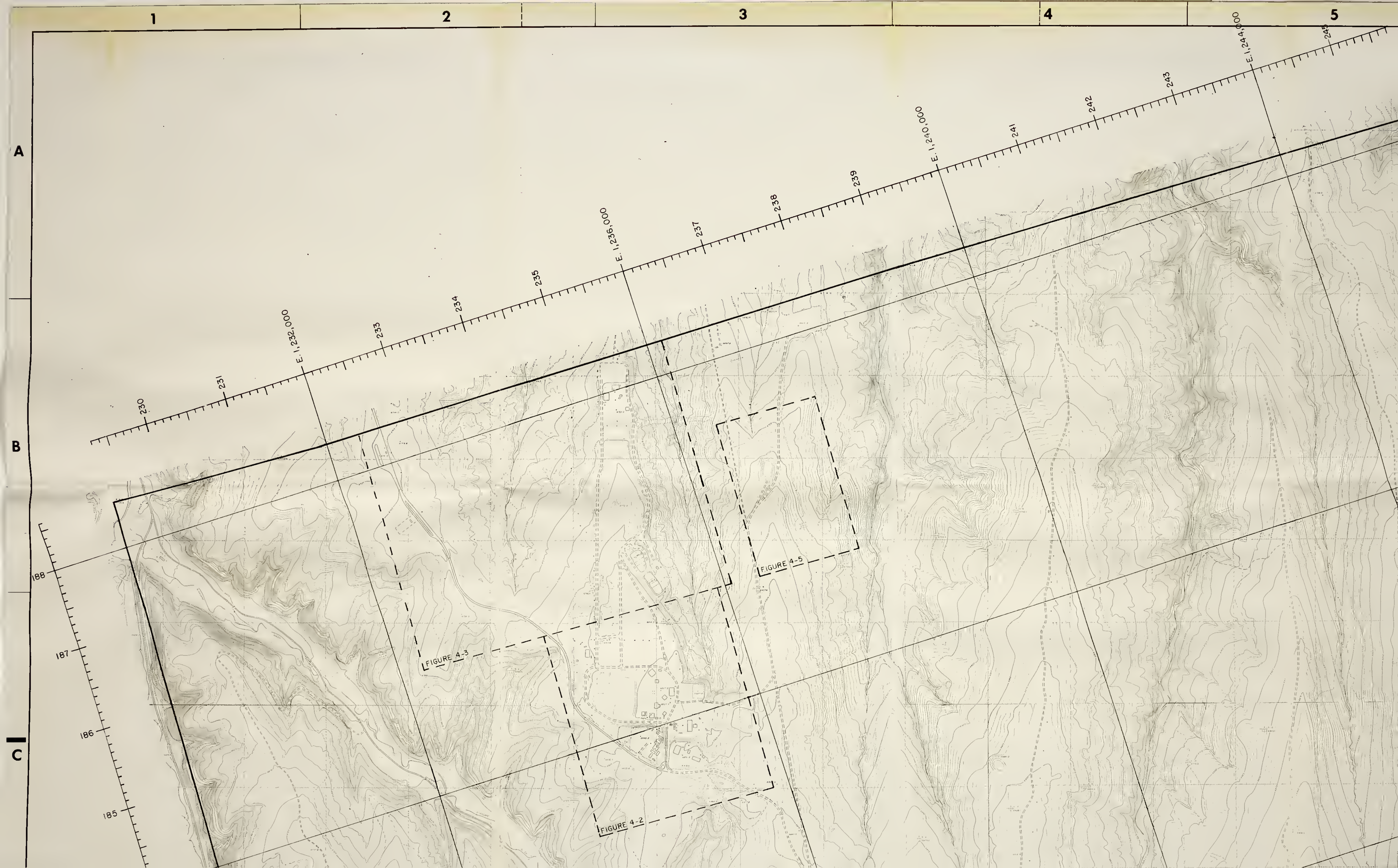
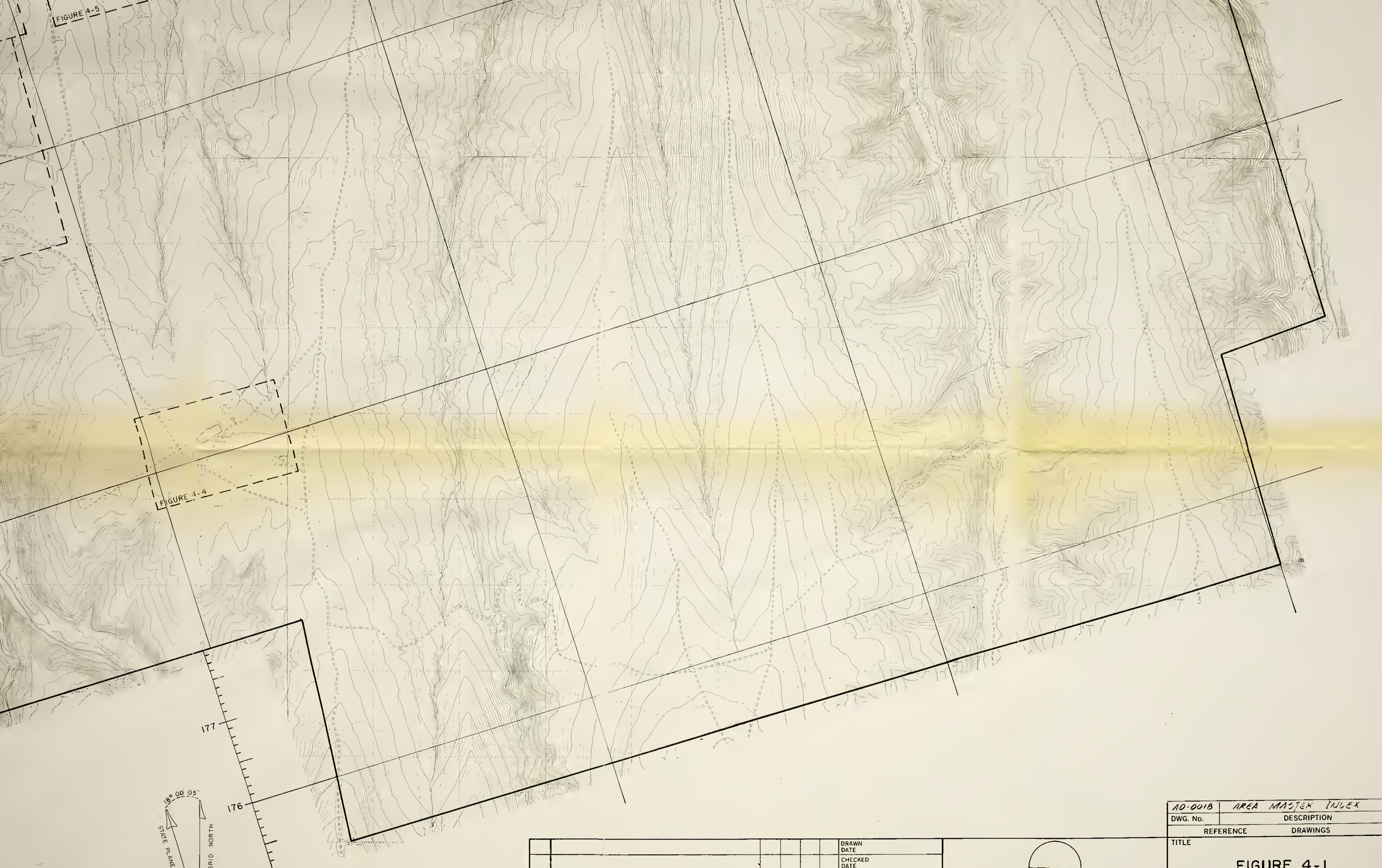


1
2
3
4
5
A
B
C
E. 1,232,000
E. 1,236,000
E. 1,240,000
E. 1,244,000
230
231
233
234
235
237
238
239
241
242
243
245
188
187
186
185
FIGURE 4-2
FIGURE 4-3
FIGURE 4-5


3
4
5
6
7
A
B
C
237
238
239
E. 1,240,000
241
242
243
E. 1,244,000
245
246
247
E. 1,248,000
249
FIGURE 4-5


FIGURE 4-5
FIGURE 4-3
FIGURE 4-2
FIGURE 4-4
188
187
186
185
164,000
183
182
181
180,000
179
178
177
176
C
D
E
THESE DRAWINGS WERE COMPILED USING AERIAL METHODS AND PHOTOGRAPHY TAKEN ON AUG.27, 1980.
GROUND SURVEY CONTROL BY CONSTRUCTION SURVEYS, INC. RIFLE, COLORADO.
PHOTOGRAMMETRIC SERVICES BY SCHARF AND ASSOCIATES, DENVER, COLORADO.
SCALE 1" = 600'
600 0 600 1200 1800
18° 00' 05"
STATE PLANE GRID NORTH
PLANT GRID NORTH
1 GRID & FIGURE Areas Out
REV.
DESCRIPTION
1/10
1/8 – 1/4
3/8 – 3/4
1/2 – 1



REV.	DESCRIPTION	DRAWN	DATE	CHK'D.	APPR.	APPROVALS
						DRAWN DATE
						CHECKED DATE
						APPROVED ENG.
						APPROVED
1	GRID & FIGURE Areas Outlined	VS	4/1/82			APPROVED

Cathedral Bluffs Shale Oil Company

PROJECT No. ESF-13.3

SCALE 1" = 600'

DWG. No.	DESCRIPTION
AD-0018	AREA MASTER INDEX

REFERENCE DRAWINGS

TITLE

FIGURE 4-1
C-b TRACT
TOPOGRAPHIC MAP

DRAWING No. AD-0017

REV. P

FOLD